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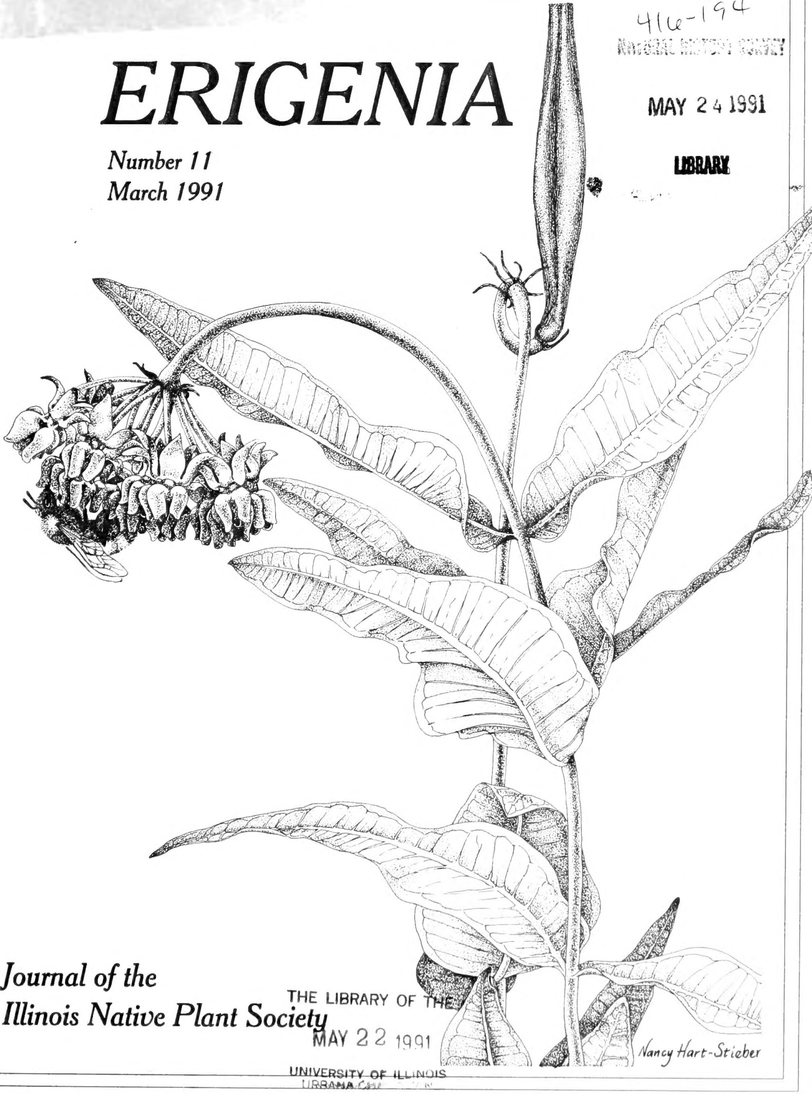

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For Society membership information, write to: **E.L. Shimp, U.S.D.A. Forest Service, Shawnee National Forest, 901 S. Commercial Street, Harrisburg, IL 62946**
The Illinois Native Plant Society is dedicated to the preservation, conservation and study of the native plants and vegetation of Illinois.

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Cover: *Asclepias meadii* Torrey (Mead's milkweed), a federally threatened plant, occurs in only four locations in Illinois.

The Vascular Flora of Langham Island, Kankakee County, Illinois[1]

John E. Schwegman

Illinois Department of Conservation
Springfield, Illinois 62701-1787

Langham Island is located in the Kankakee River at the village of Altorf, five miles northwest of Kankakee, Illinois. This 10-hectare island has long been noted for the variety of rare plants inhabiting it. Chief among these is the Kankakee Mallow (*Iliamna remota*), which is native only to this island. Early herbarium sheets indicate that the island was visited by botanists as early as 1872, however no complete vascular flora list has been compiled for the area. This paper presents such a list.

The first written record I have found of the island was made by a government land surveyor on April 7, 1834. He described it as a "beautiful timbered island that does not overflow" and called it Langham's Island (Page 98, volume 356, Public Land Survey field notes). At this time the south shore of the river was "high level rich prairie" and the north shore was timbered. Tree species listed for the area are "burr oak, white oak and hickory".

In 1834 the north shore of the river, to which the island is closest, was part of a large timbered grove which contained a major Potawotomie Indian village. Several tracts in this grove (Rock Grove) were deeded to the Indians by the Treaty of Tippecanoe. A large tract just east of the island was granted to an Indian named Joseph Laughton, son of Wais-Ke-Shaw. Since histories of the county list no Langhams among the earliest settlers, the island may have been named for Joseph Laughton and the surveyor and the authors of the treaty spelled his name differently. However, it is also possible that the surveyor named the island for a Mr. Langham who was Surveyor General of Illinois at the time. In any event, there is no evidence that Joseph Laughton ever controlled the island. The Indians were forced to cede their lands and move to Iowa in 1836 (Beckwith 1884).

Land near Langham Island was settled rapidly following the departure of the Indians. A dam was built between the island and the north shore in 1858 to provide water power for a mill that was constructed on the shore. The village of Altorf was settled at this time. The mill deteriorated before 1890, but the end of the dam and an apparent borrow area are still evident on the island.

E. J. Hill began visiting the island and collecting the unusual plants he found there in 1872. He does not describe the conditions on the island at that time, but refers to some of his visits in his letters found in Kibbe (1953). His herbarium labels describe the habitat for most of his collections as "gravelly island", "dry banks", and "gravelly bank of island". By 1912, and continuing at least until 1916, Sherff (1946) noted that the more elevated flat portion of the island was cleared and cultivated as a cornfield. He described the remaining woodland as "open woods" and "rocky grassy slopes". When Sherff returned in 1945, the field had been abandoned. Since that time the island has remained undisturbed and the field has succeeded to a brush and small-tree stage.

Langham Island became part of Kankakee River State Park in the early 1940s, and was dedicated as an Illinois Nature Preserve in 1966. Management of the island to benefit the Kankakee Mallow, under a recovery plan for that species (Schwegman 1984), began in 1983. Management has included prescribed fire and chemical control of exotic shrubs.

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[1]Editor's Note: Due to editorial errors, this article, which previously appeared in Erigenia 10, is being reprinted in its entirety. Further citations of Mr. Schwegman's article should cite Erigenia 11.

Langham Island consisted only of a flat-topped 5.4-hectare bedrock upland when first surveyed and platted in 1868. Since that time, a 4.6-hectare low alluvial area has accreted to the southeastern (upstream) end. The island is located at the upstream end of the "gorge" of the Kankakee River at a point where the river is swift, shallow and rocky. It is nearest the northern shore.

The present study area consists of this entire 10-hectare island and the aquatic habitats immediately bordering it. The natural communities present in the study area include dry upland forest on the southwest slopes, mesic upland forest on the northeast slopes, floodplain forest, late successional old field, bedrock outcrops, river banks, swift river and quiet river. The river-bank community is impacted frequently by ice-floe scouring as well as flooding.

The island is 700 meters long and a maximum of 195 meters wide. Its linear dimension tends southeast to northwest. The river elevation is approximately 170 meters above sea level, while the old field interior of the island is at an elevation of 177 meters. The highest elevation is 581 feet. The northeast side of the island has more gentle 4 to 7 percent slopes than the 18 to 30 percent slopes of the southwest side.

The soil of the flat upland is Rockton Loam, which is developed in 50 to 60 centimeters of stratified sands and silts over dolomite bedrock. The northeast slopes are Ritchey Loam, which is 25 to 60 centimeters thick on bedrock, while the steeper southwest slopes contain Sogn Loam. Sogn has less than 25 centemeters of loamy material over bedrock. This soil is gravelly with some very large cobbles in some areas. Two areas of bedrock outcrop also occur on the southwest slopes. The lower southeast end of the island has medium-textured alluvium on lower areas while the higher elevations contain Onarga Fine Sandy Loam.

Dominant plants of the late succession stage old field are Canada Bluegrass (*Poa compressa*), White Sweet Clover (*Melilotus alba*), and Goldenrod (*Solidago canadensis*). Slippery Elm (*Ulmus rubra*) and Hawthorn (*Crataegus crus-galli*) are the principal invaders of the field along with the introduced shrub, Amur Honeysuckle (*Lonicera maackii*). Mesic forests on the northeast slope are of Red Oak (*Quercus rubra*), with an understory of Bladdernut (*Staphylea trifolia*). The drier forests of the south slope are of Burr Oak (*Quercus macrocarpa*) and Blue Ash (*Fraxinus quadrangulata*), with a shrub layer of Poison Ivy (*Toxicodendron radicans*). Amur Honeysuckle and many other shrub and tree species are also common here. The lowland forests are of Green Ash (*Fraxinus pennsylvanica*), Hackberry (*Celtis occidentalis*) and American Elm (*Ulmus americana*). Cottonwood (*Populus deltoides*) is a common tree along the north shore. Swift water areas support Sago Pondweed (*Potamogeton pectinatus*) and Eelgrass (*Vallisneria americana*), while quiet waters are usually dominated by Water Weed (*Elodea canadensis*) and Curly Pondweed (*Potamogeton crispus*).Common shoreline herbs are Water Willow (*Justicia americana*) and Rose Mallow (*Hibiscus laevis*).

Among the more notable plants known from Langham Island is the Kankakee Mallow, which was first collected there by E. J. Hill on June 29, 1872. It remains abundant there today, and so far as is known, is native only to this island. The Corn Salads (*Valerianella intermedia* and *V. umbilicata*) are annuals occupying the banks and interior fields. While the latter species was abundant during this study, the former was last collected by Swink on July 2, 1966 (SIU). The Leafy Prairie Clover (*Dalea foliosa*) was first discovered on the island on August 27, 1872 by E. J. Hill. He found it growing on "gravelly banks". Realizing he had discovered a little known species, he returned July 28, 1873 to collect more. In a letter to Harry Patterson dated November 29, 1873, Hill, referring to the leafy prairie clover, writes: "In fact I found but five plants after thorough search. Four of these I dug up, sending two of the roots to Dr. (Asa) Gray, to cultivate, fearing I might exterminate; the other was left". This species has not been seen on the island since. Seeds of the Leafy Prairie Clover from Will County, Illinois were sowed along the south banks of the island in 1986 in hopes of re-establishing a population there. Buffalo Clover (*Trifolium reflexum*) was collected on the island June 13, 1884 (ILL), and the Violet (*Viola viarum*) was also collected here May 16, 1884 (ILL), both by Hill. Neither was found during the present study.

Among the unexpected species I encountered was Veiny Skullcap (*Scutellaria nervosa*), a single

specimen of which was found on a dry ledge on the south slopes. This species was later found to be common locally on the nearby north shores of the river. A few Missouri Violets (*Viola missouriensis*) were found in low woods near the south end of the island, and a single Swamp Candle (*Lysimachia terrestris*) was found on the north shore. Sedge (*Carex hitchcockiana*) and Wild Leek (*Allium burdickii*) were found in a bit of mesic forest near the old dam.

The following annotated checklist includes 315 taxa and was compiled during the 1985 growing season. It also includes a few taxa observed in 1986 and several species collected by others in prior years but apparently now extinct on the island. The taxonomy follows Mohlenbrock (1986) as to species and family names and family sequence. The genera and species are alphabetically arranged within the families. Species preceded by an asterisk (*) are alien species. Vouchers were collected and deposited at the Illinois State Museum (ISM) for the more notable species encountered.

Equisetaceae

Equisetum arvense. Common Horsetail. Local along north shore.
Equisetum hyemale. Scouring Rush. Local on moist shores.

Ophioglossaceae

Botrychium virginianum. Rattlesnake Fern. Local in mesic forest.

Aspleniaceae

Asplenium platyneuron. Ebony Spleenwort. Rare in upland forest.

Potamogetonaceae

**Potamogeton crispus*. Curly Pondweed. Common in quiet water along north shore.
Potamogeton nodosus. Pondweed. Local along north shore.
Potamogeton pectinatus. Sago Pondweed. Common in swift and quiet water.

Hydrocharitaceae

Elodea canadensis. Waterweed. Common in quiet water.
Vallisneria americana. Eelgrass. Common in swift and quiet water.

Poaceae

Andropogon gerardii. Big Bluestem. Rare on south slope.
**Agrostis alba*. Redtop. Local on moist south shore.
**Bromus inermis*. Smooth Brome. Local on dry open south slopes.
Cinna arundinacea. Stout Wood Reed. Local in upland woods.
Echinochloa crus galli. Barnyard Grass. Rare on south shore.
Elymus villosus. Slender Wild Rye. Common on forested slopes.
Elymus virginicus. Virginia Wild Rye. Local in woods.
Eragrostis frankii. Love Grass. Local on moist open river banks.
Eragrostis hypnoides. Pony Grass. Local on moist sandy shores.
**Eragrostis pilosa*. Love Grass. Common on moist shores on north side.
Festuca obtusa. Nodding Fescue. Common in mesic forest.
**Festuca pratensis*. Tall Fescue. Rare on open south slope.
Leersia virginica. White Grass. Local in alluvial forest.
Muhlenbergia bushii. Muhly. Local in alluvial forest.
Muhlenbergia frondosa. Muhly. Local in moist forest.
Muhlenbergia schreberi. Nimble Will. Rare in forest.
Panicum capillare. Witch Grass. Local on open banks.
Panicum dichotomiflorum. Fall Panicum. Local on moist shores.
Panicum virgatum. Switchgrass. Rare on the open south bank.
Phalaris arundinacea. Reed Canary Grass. Common along shores.
**Poa compressa*. Canada Bluegrass. Common in interior old field.
Poa sylvestris. Woodland Bluegrass. Common in mesic forest.
**Setaria faberi*. Giant Foxtail. Rare on open south slopes.
**Setaria lutescens*. Yellow Foxtail. Rare in interior fields.
Spartina pectinata. Cordgrass. Local on moist south banks.
Sphenopholis obtusata. Wedge Grass. Local in woods.

Cyperaceae

Carex blanda. Woodland Sedge. Common in woods.
Carex cephalophora. Sedge. Local on dry slopes.
Carex davisii. Sedge. Local on south slope.
Carex gravida. Sedge. Local in upland woods.
Carex hitchcockiana. Hitchcock's Sedge. Local in woods at old dam site.
Carex jamesii. James's Sedge. Rare in mesic forest.
Carex normalis. Sedge. Local in old field.
Carex pensylvanica. Penn Sedge. Local on dry open south slope.
Carex sparganioides. Sedge. Rare in woods.
Carex stricta. Clumped Sedge. Rare along south shore.
Carex vulpinoidea. Fox Sedge. Local along south shore.
Cyperus aristatus. Galingale. Rare along north shore.
Cyperus erythrorhizos. Galingale. Common on north shore.
Eleocharis elliptica. Spike Rush. Local along north shore.
Scirpus americanus. Three-square Bulrush. Local on shore near north end.
Scirpus micranthus. Small Bulrush. Rare along north shore.

Araceae

Arisaema dracontium. Green Dragon. Local in alluvial woods.

Lemnaceae

Lemna minor. Common Duckweed. Local in quiet water around island.

Commelinaceae

Tradescantia ohiensis. Ohio Spiderwort. Local in fields.

Liliaceae

Allium burdickii. Wild Leek. Rare in woods by old mill dam.
Allium canadense. Wild Onion. Common in woods.
Allium cernuum. Nodding Onion. Local in old field and on dry slopes.
**Asparagus officinalis*. Asparagus. Local in woods and on banks.
Camassia scilloides. Wild Hyacinth. Common on south slopes.
**Hemerocallis fulva*. Day Lily. Rare along north shore.
Polygonatum commutatum. Solomon's Seal. Local in woods.
Smilacina stellata. False Solomon's Seal. Reported by Payton in 1973.
Trillium recurvatum. Wake Robin. Local in dry woods on south slope.
Trillium sessile. Sessile Wake Robin. Common in mesic and moist woods.

Smilacaceae

Smilax ecirrata. Carrion Flower. Local in woods.
Smilax lasioneuron. Carrion Flower. Local in woods.
Smilax hispida. Bristly Greenbrier. Local in mesic woods.

Dioscoreaceae

Dioscorea villosa. Wild Yam. One large population in dry woods.

Iridaceae

**Belamcanda chinensis*. Blackberry Lily. Rare on south slope.
**Iris X germanica*. Bearded Iris. One population in old field.
Iris shrevei. Wild Blue Iris. Local along shore.

Salicaceae

Populus deltoides. Cottonwood. Local along north shore.
Salix exigua. Sandbar Willow. Rare on south banks.

Juglandaceae

Carya cordiformis. Bitternut Hickory. Rare in woods.
Carya ovata. Shagbark Hickory. Rare in woods.
Juglans nigra. Black Walnut. Local in low woods.

Fagaceae

Quercus alba. White Oak. Local in woods.
Quercus bicolor. Swamp White Oak. Local in low woods.
Quercus macrocarpa. Burr Oak. Common on south side.
Quercus prinoides var. *acuminata*. Yellow Chestnut Oak. Local on south side.
Quercus rubra. Northern Red Oak. Local in woods.

Ulmaceae

Celtis occidentalis. Hackberry. Local in low woods.
Ulmus americana. American Elm. Local along north shore.

Ulmus rubra. Slippery Elm. Local in upland woods and fields.

Urticaceae

Boehmeria cylindrica. False Nettle. Local in moist soil.
Laportea canadensis. Stinging Nettle. Rare on moist banks.

Parietaria pensylvanica. Pellitory. Rare in woods.
Pilea pumila. Clearweed. Local along north shore.
Urtica dioica. Stinging Nettle. Local along north shore.

Aristolochiaceae

Asarum canadense. Wild Ginger. Common in mesic woods.

Polygonaceae

Polygonum amphibium. Water Smartweed. Rare along north shore.
**Polygonum aviculare*. Knotweed. Local on dry south banks.
Polygonum lapathifolium. Nodding Smartweed. Local along north shore.
Polygonum pensylvanicum. Common Smartweed. Local on shores.
**Polygonum persicaria*. Lady's Thumb. Local on north shore.
Polygonum punctatum. Smartweed. Local on north shore.
Polygonum scandens. False Buckwheat. Local in woods and on open banks.
Rumex crispus. Curly Dock. Local on river banks.
Rumex verticillatus. Water Dock. Local along shore.

Chenopodiaceae

Chenopodium album. Lamb's Quarters. Local in fields and on banks.
Chenopodium gigantospermum. Maple-leaved Goosefoot. Rare on dry banks.
Chenopodium standleyanum. Goosefoot. Common in woods.

Amaranthaceae

Amaranthus rudis. Water Hemp. Local on moist shores.

Nyctaginaceae

Mirabilis nyctaginea. Wild Four-o'clock. Local on dry banks.

Portulacaceae

Claytonia virginica. Spring Beauty. Local in woods.

Caryophyllaceae

Cerastium arvense. Field Mouse-eared Chickweed. Local on dry south bank.
Silene antirrhina. Sleepy Catchfly. Rare on an uprooted stump.
**Silene cucubalus*. Bladder Catchfly. Rare on dry south banks.
Silene stellata. Starry Campion. Local in dry woods.

Ceratophyllaceae

Ceratophyllum demersum. Coontail. Local in quiet water around island.

Ranunculaceae

Anemone virginiana. Tall Anemone. Local in woods and on banks.
Clematis pitcheri. Leatherflower. Common on dry open banks.
Ranunculus abortivus. Small-flowered Crowfoot. Local in all communities.
Ranunculus micranthus. Small-flowered Buttercup. Local in woods.
Ranunculus septentrionalis. Swamp Buttercup. Local in moist areas.
Thalictrum revolutum. Waxy Meadow Rue. Local in moist woods.

Berberidaceae

**Berberis vulgaris*. Common Barberry. Rare on south slopes.
Podophyllum peltatum. Mayapple. Rare near old mill site.

Menispermaceae

Menispermum canadense. Canada Moonseed. Rare on moist banks.

Papaveraceae

Corydalis micrantha. Slender Corydalis. Rare on dry south banks.
Dicentra cucullaria. Dutchman's Breeches. Common in north slope woods.

Brassicaceae

Arabis laevigata. Smooth Rock Cress. Local in woods.
Arabis shortii. Rock Cress. Common in low areas all around the island.
**Brassica nigra*. Black Mustard. Common on dry open banks.
Dentaria laciniata. Toothwort. Common in slope woods.
Descurainia pinnata. Tansy Mustard. Rare on limestone ledges.
Iodanthus pinnatifidus. Purple Rocket. Local in low woods.

**Lepidium campestre*. Field Peppergrass. Local on river banks.
**Lepidium densiflorum*. Peppergrass. Local on dry south slopes.
**Rorippa sylvestris*. Creeping Yellow Cress. Common on river banks.

Crassulaceae

**Sedum sarmentosum*. Yellow Stonecrop. Rare on rocks on south bank.
Sedum ternatum. Three-leaved Stonecrop. Very local on south banks.

Grossulariaceae

Ribes missouriense. Missouri Gooseberry. Common in all communities.

Rosaceae

Agrimonia parviflora. Agrimony. Local in level upland woods.
Agrimonia pubescens. Soft Agrimony. Local in upland woods.
Crataegus crus-galli. Cock-Spur Thorn. Local in fields and woods.
Crataegus mollis. Red Haw. Common in alluvial forest.
Geum canadense. White Avens. Common in woods.
Geum laciniatum. Rough Avens. Rare on moist shores.
Geum vernum. Spring Avens. Local in alluvial woods.
Malus ioensis. Iowa Crabapple. Local in fields and woods.
**Potentilla recta*. Sulphur Cinquefoil. Rare in old field.
Prunus americana. Wild Plum. Local on dry south banks.
Prunus serotina. Wild Black Cherry. Local in fields and woods.
Prunus virginiana. Choke Cherry. Common in upland woods.
Rosa carolina. Pasture Rose. Local on dry south banks.
**Rosa multiflora*. Multiflora Rose. Common in woods and fields.
Rosa setigera. Prairie Rose. Rare in successional forest.
Rosa suffulta. Sunshine Rose. Rare on dry south banks.
Rubus occidentalis. Blackberry. Local in fields and woods.

Mimosaceae

Desmanthus illinoensis. Illinois Mimosa. Local on dry banks.

Caesalpiniaceae

Cassia marilandica. Maryland Senna. Local on south slopes.
Cercis canadensis. Redbud. Common in fields and woods.
Gleditsia triacanthos. Honey Locust. Rare in woods and fields.

Fabaceae

Amorpha fruticosa. False Indigo. Local along shores.
Amphicarpa bracteata. Hog Peanut. Local in moist woods.
Apios americana. Ground Nut. Rare on moist north banks.
Dalea foliosa. Leafy Prairie Clover. Formerly on dry banks, reintroduced in 1987.
**Medicago lupulina*. Black Medic. Rare on dry south

banks.
Trifolium reflexum. Buffalo Clover. Formerly in dry open woods.

Oxalidaceae
Oxalis dillenii. Yellow Wood Sorrel. Local on dry banks.
Oxalis stricta. Yellow Wood Sorrel. Local on dry banks.

Rutaceae
Ptelea trifoliata. Wafer Ash. Local along north bank.
Xanthoxylum americanum. Prickly Ash. Local in woods.

Simaroubaceae
**Ailanthus altissima*. Tree-of-heaven. Local in field.

Euphorbiaceae
Acalypha rhomboidea. Three-seeded Mercury. Local on moist shores.
Acalypha virginica. Three-seeded Mercury. Local on river banks.
Chamaesyce humistrata. Milk Spurge. Local on dry banks.
Chamaesyce maculata. Nodding Spurge. Local on dry banks.
Poinsettia dentata. Wild Poinsettia. Dry gravel around burned logs.

Limnanthaceae
Floerkea proserpinacoides. False Mermaid. Common in low and mesic woods.

Anacardiaceae
Rhus glabra. Smooth Sumac. Local in fields.
Toxicodendron radicans. Poison Ivy. Common in woods.

Staphyleaceae
Staphylea trifolia. Bladdernut. Common in north slope woods.

Aceraceae
Acer negundo. Box Elder. Local in low alluvial woods.
Acer saccharinum. Silver Maple. Local along shore at north end.

Rhamnaceae
**Rhamnus cathartica*. Common Buckthorn. Rare in open woods.

Vitaceae
Parthenocissus quinquefolia. Virginia Creeper. Local in slope woods.
Vitis riparia. Riverbank Grape. Local in low woods.

Tiliaceae
Tilia americana. Basswood. Local along upper south banks.

Malvaceae
Hibiscus laevis. Halberd-leaved Rose Mallow. Local along shores.
Iliamna remota. Kankakee Mallow. Local in dry woods and fields on south side.

Hypericaceae
Hypericum sphaerocarpum. Round-fruited St. John's Wort. Common on open south banks.

Violaceae
Viola missouriensis. Missouri Violet. Rare in low woods.
Viola pratincola. Smooth Violet. Local in afforested upland.
Viola pubescens. Downy Yellow Violet. Local in wet woods.
Viola sororia. Woolly Blue Violet. Local in mesic woods.
Viola viarum. Violet. Collected from dry banks in 1884.

Elaeagnaceae
**Elaeagnus umbellata*. Autumn Olive. Rare in open field.

Lythraceae
**Lythrum salicaria*. Purple Loosestrife. Rare as seedlings along north shore.

Onagraceae
Ludwigia palustris. Marsh Purslane. Local on moist shores.

Oenothera biennis. Biennial Evening Primrose. Local on dry banks.

Apiaceae
Chaerophyllum procumbens. Wild Chervil. Local in woods.
Cryptotaenia canadensis. Honewort. Local in moist woods.
**Daucus carota*. Queen Anne's Lace. Local in fields.
Osmorhiza longistylis. Anise-root. Local in moist to mesic woods.
Perideridia americana. Common on dry south slopes.
Sanicula canadensis. Canadian Black Snakeroot. Common in moist woods.
Sanicula gregaria. Common Snakeroot. Local in mesic woods.
**Torilis japonica*. Hedge Parsley. Local in fields.
Zizia aurea. Golden Alexanders. Local along south banks.

Cornaceae
Cornus racemosa. Gray Dogwood. Common in woods by old dam.
Cornus stolonifera. Red Osier Dogwood. Local on river banks.

Primulaceae
Androsace occidentalis. Rare in open sandy old field.
Lysimachia ciliata. Fringed Loosestrife. Rare along the north bank.
**Lysimachia nummularia*. Moneywort. Local in moist woods.
Lysimachia terrestris. Swamp Candles. Rare (one plant) along north shore.

Oleaceae

Fraxinus pennsylvanica. Green Ash. Local in woods and fields.
Fraxinus quadrangulata. Blue Ash. Local on south slopes.

Apocynaceae

Apocynum cannabinum. Dogbane. Local in fields.
**Vinca minor*. Periwinkle. Rare in woods near old dam.

Asclepiadaceae

Asclepias incarnata. Swamp Milkweed. Local along shores.
Asclepias syriaca. Common Milkweed. Rare on low open shore.

Convolvulaceae

Calystegia sepium. American Bindweed. Common on low north banks.
Ipomoea pandurata. Wild Sweet Potato. Local on north banks.

Polemoniaceae

Phlox divaricata. Wild Sweet William. Local in woods.

Hydrophyllaceae

Ellisia nyctelea. Aunt Lucy. Local on dry wooded slopes.
Hydrophyllum appendiculatum. Great Waterleaf. Local in mesic woods.
Hydrophyllum virginianum. Virginia Waterleaf. Local in slope forest.

Boraginaceae

**Cynoglossum officinale*. Hound's Tongue. Rare in field.
Mertensia virginica. Virginia Bluebells. Rare in low woods at west end.
Onosmodium hispidissimum. Marbleseed. Rare at east end of field.

Verbenaceae

Phyla lanceolata. Fog Fruit. Common on moist shores.
Verbena hastata. Blue Vervain. Local on moist banks.
Verbena simplex. Narrow-leaved Vervain. Rare on dry rocky banks.
Verbena urticifolia. White Vervain. Local on dry banks.

Lamiaceae

Agastache nepetoides. Yellow Giant Hyssop. Local on banks and in woods.
**Glechoma hederacea*. Ground Ivy. Local in low moist woods.
**Leonurus cardiaca*. Motherwort. Local in fields.
Lycopus americanus. Common Water Horehound. Rare on banks at west end.
**Mentha x piperita*. Peppermint. Rare on south bank.
Monarda fistulosa. Bee Balm. Local in fields and on dry banks.
Physostegia speciosa. False Dragonhead. Rare on north banks.
Scutellaria lateriflora. Mad Dog Skullcap. Local along south bank.
Scutellaria nervosa. Veiny Skullcap. Rare (one plant) on limestone outcrop.
Stachys tenuifolia. Smooth Hedge Nettle. Local along moist north banks.
Teucrium canadense. American Germander. Local on dry banks and in woods.

Solanaceae

Physalis heterophylla. Ground Cherry. Rare on south banks.
Solanum carolinense. Horse-nettle. Local on dry banks.
**Solanum dulcamara*. Bittersweet Nightshade. Rare near shore at west end.
Solanum ptycanthum. Black Nightshade. Local on banks.

Scrophulariaceae

Agalinis tenuifolia. Slender False Foxglove. Common along shores.
Dasistoma macrophylla. Mullein Foxglove. Common in fields.
Leucospora multifida. Rare on sandy banks.
Mimulus ringens. Monkey-flower. Local on moist banks.
Penstemon digitalis. Foxglove Beardstongue. Common on banks and in woods.
Scrophularia marilandica. Late Figwort. Local on dry banks.
**Verbascum thapsus*. Woolly Mullein. Local in fields and on slopes.

Acanthaceae

Justicia americana. Water Willow. Common in shallow water along shores.
Ruellia humilis. Wild Petunia. Local on dry banks.
Ruellia strepens. Smooth Wild Petunia. Local in woods.

Plantaginaceae

**Plantago major*. Common Plantain. Local in disturbed areas.
Plantago rugelii. Rugel's Plantain. Local on dry banks.

Rubiaceae

Cephalanthus occidentalis. Buttonbush. Rare along south shore.
Galium aparine. Goose Grass. Common in woods.
Galium circaezans. Bedstraw. Local in woods.

Caprifoliaceae

**Lonicera maackii*. Amur Honeysuckle. Common throughout island.
Lonicera prolifera. Grape Honeysuckle. Local on south slopes.
**Lonicera tatarica*. Tartarian Honeysuckle. Local in fields and woods.
Symphoricarpos orbiculatus. Coralberry. Rare at edge of field.
Viburnum prunifolium. Black Haw. Local in woods.

Valerianaceae

Valerianella intermedia. Corn Salad. Rare, last collected in 1966.
Valerianella umbilicata. Corn Salad. Common in fields and on dry banks.

Campanulaceae

Lobelia cardinalis. Cardinal Flower. Rare on north shore.
Lobelia siphilitica. Great Blue Lobelia. Local along shores.
Triodanis perfoliata. Venus's Looking Glass. Rare in disturbed field.

Asteraceae

Achillea millefolium. Yarrow. Local in the field.
Ambrosia artemisiifolia. Common Ragweed. Common in disturbed sites.
Ambrosia trifida. Giant Ragweed. Rare in moist soil at south end.
Artemisia biennis. Biennial Wormwood. Rare on dry south bank.
Aster drummondii. Drummond's Aster. Rare in mesic forest.
Aster novae-angliae. New England Aster. Rare on dry south banks.
Aster ontarionis. Ontario Aster. Local in alluvial and upland woods.
Aster pilosus. Hairy Aster. Local on dry banks on south side.
Aster shortii. Short's Aster. Common in dry woods on south side.
Aster vimineus. Aster. Local on north side.
Bidens bipinnata. Spanish Needles. Rare in upland woods.
Bidens cernua. Nodding Bur Marigold. Common along shores.
Bidens connata. Swamp Beggar-ticks. Local along shores.
Bidens frondosa. Common Beggar-ticks. Common on north shore.
Bidens vulgata. Tall Beggar-ticks. Rare on south banks.
Brickellia eupatorioides. False Boneset. Local in field.
**Cirsium arvense*. Canada Thistle. Rare on dry banks.
Cirsium discolor. Field Thistle. Local in field.
Conyza canadensis. Muletail. Rare on dry banks.
Eclipta prostrata. Yerba de Tajo. Rare along south shore.
Erigeron annuus. Daisy Fleabane. Local in fields.
Erigeron philadelphicus. Marsh Fleabane. Local on moist banks.
Erigeron strigosus. Daisy Fleabane. Local in dry fields and banks.
Eupatorium altissimum. Tall Boneset. Local in old field.
Eupatorium maculatum. Spotted Joe-Pye-Weed. Local on moist banks.
Eupatorium rugosum. White Snakeroot. Common in woods.
Eupatorium serotinum. Late Boneset. Local on dry south banks.
Helenium autumnale. Autumn Sneezeweed. Local along moist banks.
Helianthus divaricatus. Woodland Sunflower. Rare in dry woods.
Helianthus strumosus. Pale-leaved Sunflower. Rare on dry banks.
Heliopsis helianthoides. False Sunflower. Local on dry open south banks.
Lactuca floridana. Wild Blue Lettuce. Common in mesic woods.
**Lactuca serriola*. Prickly Lettuce. Local in field.
Prenanthes crepidinea. Great White Lettuce. Rare on south wooded slope.
Ratibida pinnata. Gray Coneflower. Local in field and on south banks.
Rudbeckia laciniata. Golden Glow. Common in moist woods.
Senecio aureus. Golden Ragwort. Rare in old field.
Silphium perfoliatum. Cup Plant. Local on north banks.
Solidago canadensis. Tall Goldenrod. Local on dry banks and in field.
Solidago gigantea. Late Goldenrod. Local in moist woods.
**Sonchus asper*. Spiny Sow Thistle. Local on south banks.
**Taraxacum officinale*. Dandelion. Local in disturbed sites.
**Tragopogon dubius*. Goat's Beard. Local on south bank.
Verbesina alternifolia. Yellow Ironweed. Common in alluvial forest.
Verbesina helianthoides. Yellow Crownbeard. Local on south banks.
Vernonia gigantea. Tall Ironweed. Local in moist ground.
Vernonia missurica. Missouri Ironweed. Local in field and on south bank.
Xanthium strumarium. Cocklebur. Local on river banks.

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New Records for Illinois Vascular Plants

John E. Schwegman

Illinois Department of Conservation
Springfield, Illinois 62701-1787

ABSTRACT

Lysimachia × *producta* (Gray) Fern., *Mirabilis hirsuta* (Pursh) MacM., *Carex heliophila* Mack., and the hybrid *Lespedeza leptostachya* Engelm. × *L. capitata* Michx. are reported as natives of Illinois for the first time. Significant distributional records for 21 additional taxa are also reported.

INTRODUCTION

Field work, associated with developing and implementing a native plant conservation program at the Department of Conservation during the 1980s, has led to the discovery of several occurrence and distributional records for Illinois vascular plants. This paper reports some of the more notable of these finds. A voucher specimen has been deposited in the Herbarium of the Illinois State Museum (ISM) in support of each record reported here.

TAXA NEW TO ILLINOIS

Lysimachia* × *producta (Gray) Fern. is a fertile hybrid derived from *L. terrestris* (L.) BSP. and *L. quadrifolia* L.. Gleason and Cronquist (1963) give its range as Maine to North Carolina west to Wisconsin and Kentucky. Collection data: a large colony growing on top of the high bank of the Ohio River at the mouth of Cane Creek, one mile southeast of Saline Landing, Hardin County, July 3, 1988, Schwegman #3195.

Carex heliophila Mack. is a western sedge of coarse soil prairies that is known from Indiana west to the Great Plains. It resembles *C. pensylvanica* Lam. but has larger perigynia and fewer spikes. In spite of its attribution to Illinois by Gleason and Cronquist (1963) and Fernald (1950) as *C. pensylvanica* Lam. var. *digyna* Boeckl., it is not listed for the state by Mohlenbrock (1986). Collection data: in a sand hill prairie adjacent to the north side of Hanover Bluff Nature Preserve, Jo Daviess County, May 26, 1985, Schwegman *s.n.*

Mirabilis hirsuta (Pursh) MacM. is listed by Mohlenbrock (1986) as a rare adventive in Illinois from the western states. Gleason and Cronquist (1963) list it as native from Wisconsin and Missouri westward. Hartley (1966) reports it from upland prairies in LaCrosse and Trempealeau Counties adjacent to the Mississippi River in Wisconsin. Randy Nyboer and I discovered this species growing in a sand hill prairie in JoDaviess County. At this location it grows in a relatively undisturbed prairie opening surrounded by forest on bluffs adjacent to the Mississippi River. It seems very unlikely that it is adventive at this site and we consider it native here. We later discovered it growing in disturbed sand prairie in the nearby Savanna Army Depot. Collection data: sand hill prairie just north of Hanover Bluff Nature Preserve, Jo Daviess County, July 27, 1983, Nyboer & Schwegman *s.n.*, and disturbed sand prairie in the wildlife management area at the north end of Savanna Army Depot, Jo Daviess County, August 10, 1989, Nyboer & Schwegman *s.n.*

Lespedeza leptostachya Engelm. × ***L. capitata*** Michx. is an apparently unnamed hybrid. While not mentioned in the manuals at hand, it has been reported from Iowa by Clewell (1966). Although *Lespedezas* readily hybridize, this hybrid would be expected to be rare because of the rarity of its first parent. At any rate, Mohlenbrock (1986) does not list it from Illinois. A few plants of this taxon were brought to my attention by Tim Keller in a dry upland prairie northwest of Franklin Grove in Lee County. The site supports good populations of both presumed parent species. The specimens most nearly resemble *L. leptostachya* as regards the shape and distribution of flower heads, but the leaves and the overall plant are larger in all respects than *L.*

leptostachya, and the leaves are densely sericeous. Collection data: dry prairie at Nachusa Grassland Preserve, northwest of Franklin Grove, Lee County, August 13, 1987, Schwegman *s.n.*

NEW DISTRIBUTION RECORDS

Agalinis fasciculata (Ell.) Raf. was found growing in mesic sand prairie in Mason County over 100 miles north of its most northerly previous record in the state. Collection data: mesic sand paririe, Matanzas Prairie Nature Preserve north of Bath, Mason County, September 23, 1987, Schwegman *s.n.*

Cacalia suaveolens L. is a seldom collected species of moist open habitats in Illinois. Collection data: moist soil at the south side of the mouth of a hollow adjacent to the Ohio River 3/4 mile north of Finneyville, Hardin County, July 3, 1988, Schwegman *s.n.*

Carex bromoides Schk., a sedge of seepage areas and near springs, has not been previously reported from the Wabash drainage of Illinois. Collection data: in a seep spring in the northwest corner of Red Hills State Park, Lawrence County, May 20, 1987, Fink & Schwegman *s.n.*

Carex laxiculmis Schwein. is a species of mesic forests in deep ravines. Collection data: along a spring branch in forests at the southeast edge of the old Siloam Village at Siloam Springs State Park, Brown County, June 1, 1984, Schwegman #3184; and on a north-facing forested slope along Lusk Creek about 1 mile northeast of Manson Ford, Pope County, May 29, 1988, Schwegman *s.n.* The latter record is the first for southeastern Illinois. It grows here with an notable assemblage of plants, including *C. careyana* Dewey, *Cimicifuga rubifolia* Kearney, *Oxalis illinoensis* Schwegman and *Dryopteris goldiana* (Hook.) Gray.

Carex oligosperma Michx. is a northern bog sedge that has not been previously reported from McHenry County. Collection data: south edge of the Leatherleaf Bog Nature Preserve, Moraine Hills State Park, McHenry County, July 14, 1988, Schwegman #3196.

Carex prasina Wahl. has previously been reported in Illinois only from the edges of seeps and along spring branches in forested ravines in western Illinois. Todd Fink and I encountered it in similar habitats in southeastern Illinois. Collection data: around seep springs in the northwest corner of Red Hills State Park, Lawrence County, May 20, 1987, Fink & Schwegman *s.n.*

Cyperus grayioides Mohl. has previously only been reported as far north in the Mississippi Valley as Carroll County, Illinois. This report extends its known range to the north. Collection data: large dune in west-central part of Savanna Army Depot, Jo Daviess County, June 27, 1984, Nyboer & Schwegman #3186.

Diervilla lonicera Mill. is a northeastern species that is reported here from west-central Illinois for the first time. Collection data: on top of a sandstone boulder along Little Tennessee Creek northwest of Mt. Sterling, Brown County, June 15, 1988, Lindsay & Schwegman *s.n.*

Gaillardia pulchella Foug. was found growing in gravelly soil of an unmown portion of a cemetery within the Wabash Valley of Lawrence County. Although generally considered an introduced species this far north and east, the possibility exists that it is a remnant of the original flora of old Allison Prairie, the presettlement limits of which include the cemetery. Allison Prairie was one of the largest prairies in southeastern Illinois and was situated on a gravel terrace at the junction of the Wabash and Embarrass rivers. Another cemetery within this former prairie's limits west of Russellville, supports a fine growth of *Buchloe dactyloides* (Nutt.) Engelm., which could also be a western floral element of this prairie. Collection data: Otterburn Cemetery southeast of the Lawrenceville and Vincennes Airport, Lawrence County, June 29, 1988, Schwegman *s.n.*

Heterotheca latifolia Buckl. is a species of dry open sandy soil. Collection data: disturbed weedy area near a railroad at the west edge of Cahokia, St.Clair County, September 2, 1987, Schwegman *s.n.*

Hypericum adpressum Bart. is a species of open, moist, sandy situations, that has rarely been collected in the state. This is the first report of it from central Illinois. Collection data: moist sandy soil at the edge of a county road, Shick Shack Nature

Preserve south of Bluff Springs, Cass County, June 25, 1985, Schwegman *s.n.*

Lespedeza* × *simulata Mack. & Bush is a seldom collected taxon reputed to be a hybrid of *L. capitata* Michx. and *L. virginica* (L.) Britt. The specimen reported here should help to confirm this hybrid origin, as I found it growing with a mixed stand of the presumed parent species. This collection sheet includes specimens of both apparent parents and *L.* × *simulata*. Collection data: on the north shoulder of Wilderness Road at Castle Rock State Park, Ogle County, August 26, 1982, Schwegman #3153.

Opuntia fragilis (Nutt.) Haw. was reported from Jo Daviess County, Illinois by Gleason (1910). However, efforts to confirm the continued existence of this cactus in Illinois were hampered by the inclusion of Gleason's collecting locality within the Savanna Army Depot in 1917. In 1984 Randy Nyboer and I received permission to search for this species within the Depot grounds. We were rewarded with the discovery of a large, healthy population of the fragile prickly pear. Collection data: heavily grazed sand prairie in the east-central part of the Savanna Army Depot, Jo Daviess County, June 27, 1984, Nyboer & Schwegman #3198.

Oryzopsis racemosa (J. E. Smith) Ricker. is recorded from scattered counties in northern Illinois, but this is the first record from Bureau County. Collection data: north-facing, forested slopes of the large ravine at Miller-Anderson Woods Nature Preserve, Bureau County, September 8, 1988, Schwegman *s.n.*

Poa nemoralis L. is an adventive species that has rarely been reported from Illinois. While conducting an environmental impact analysis of a ravine in Lake Forest, Randy Heidorn and I found it to be quite common at the upper edge of ravines and in adjacent level disturbed forest. Collection data: in and adjacent to forested ravines, Lake Forest, Lake County, May 16, 1985, Heidorn and Schwegman *s.n.*

Poa wolfii Scribn. is a bluegrass of forests that has rarely been seen in Illinois in the 20th century. I discovered it in western Illinois, where it grows in dry open forest about 1/3 of the way up southwest-facing ridges. It is a slender, fragile species that disappears rapidly after flowering except for a tuft of sterile leaves. It is best found in early June and is probably more common in western Illinois than past collecting records would indicate. Collection data: southeast of the old Siloam Village, Siloam Springs State Park, Brown County, June 16, 1984, Schwegman #3185.

Polanisia jamesii (T.& G.) Iltis was reported as locally common in some Illinois sand areas by Gleason (1910). However, it has rarely been collected in recent decades. Collection data: common in heavily grazed sandy blowouts at Savanna Army Depot, Jo Daviess County, June 27, 1984, Schwegman #3184 and August 10, 1989, Nyboer & Schwegman *s.n.*

Polygonum arifolium L. var. ***pubescens*** (Keller) Fern. is an extremely rare taxon in Illinois. Todd Fink and I found a healthy population of it in Lawrence County. Collection data: in seep springs and along spring branches in the northwest corner of Red Hills State Park, Lawrence County, May 20, 1987, Fink & Schwegman *s.n.*

Rubus alumnus Bailey is a strikingly beautiful, upright blackberry with exceptionally broad petals and abundant, glandular pubescence in the inflorescence. Mohlenbrock (1986) reports it in Illinois only from Jackson and Wabash Counties. Swink and Wilhelm (1979) include all previous reports of this species group in the Chicago area under *R. pensylvanicus* Poir. The distinctive leaves and flowers seem to separate clearly the specimen at hand from *R. pensylvanicus*. Collection data: edge of woods near the west end of Iroquois County Conservation Area, Iroquois County, June 2, 1983, Schwegman *s.n.*

Salvia azurea Michx. & Lam. var. ***grandiflora*** Benth. has been found in scattered locations in Illinois. This is its first report from northwestern Illinois. Collection data: pastured sand prairie at Savanna Army Depot, Jo Daviess County, August 11, 1989, Nyboer & Schwegman *s.n.*

Valeriana pauciflora Michx. is an eastern forest species reaching the western limits of its distribution in Illinois. A Scott County collection was previously the most westerly. The colony reported here now extends its range west of the Illinois River. Collection data: mesic, forested, north-facing slopes

along McKee Creek at Wilson Ford (mouth of Rattlesnake Den Hollow), Pike County, May 23, 1985, Schwegman *s.n.*

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Illinois' Native Snowberry

Dick Young

Kane County Environmental Department
Geneva, Illinois 60134

Until recently, the only colony of Snowberry (*Symphoricarpos albus* (L.) Blake) indigenous to Illinois was believed to occur at Mooseheart Ravine in Kane County. We now know of a second colony of about 150 plants growing in a similar habitat on the St. Peter sandstone bluffs along the Fox River north of Wedron, Illinois. Here I describe the colony at the Mooseheart Ravine, an interesting and lovely place with creviced, 15 to 20 foot Niagaran Dolomite walls, carved by the clear, rippling water of Mill Creek. Mill Creek drains from the northwest into the Fox River just south of Batavia. In most places along this quarter-mile-long ravine and valley, steep banks of silty clay loam rise another 15 to 20 feet above the bedrock. A number of unusual and fascinating plant communities occur along Mill Creek in this area, ranging from rich wetlands and mesic woods to hillside savanna and open prairie.

Lacy, pale-green Bulblet Ferns (*Cystopteris bulbifera*(L.) Bernh.) inhabit gravel bars and mossy boulder pockets near the water's edge, and wiry, dark-stemmed clusters of Purple Cliff Brake (*Pellaea glabella* Mett.) cling to the rock wall crevices, draping themselves in open cascades of dusky green, revolute leaves. Here and there small ledges and niches support Chickweed (*Cerastium arvense* L. var. *villosum* (Muhl.) Hollick & Britt.), Wild Columbine (*Aquilegia canadensis* L.), and a few wisps of Blue Grass (*Poa compressa* L.). From above, stringers of Virginia Creeper (*Parthenocissus quinquefolia* (L.) Planch.) and Black Raspberry (*Rubus occidentalis* L.) hang down the rock face, and above that a panoply of sprawling shrubs and canopy trees lean out over the edge, seeking the light of the open valley. At the top of the bluff, on the north bank just west of an old railroad bridge, is a prairie opening, and along the steep southerly slope extending into woodland is the small colony of Snowberry. There are 35 to 50 plants here appearing vigorous, except for the serious threat of Amur Honeysuckle (*Lonicera maackii* Maxim.), which is suppressing many fine, nearby plants.

Besides the Honeysuckle, there is a wide assortment of native associates present (see Table 1). Both the prairie and the woodland species mix wonderfully with this open colony of Snowberry, creating a wonderfully rich habitat.

Our native Snowberry is a charming, compact little shrub less than 30 inches tall, with fine, twiggy branchlets and shredding, light gray bark. The blue-green, wavy-toothed, elliptic-ovate leaves turn a vibrant orange and yellow fall color. In June, inconspicuous light-pink flowers are produced which are campanulate in form. The pea-sized, glistening white berry clusters are remarkably showy from mid-September to early December after the leaves have fallen. This plant would serve equally well both on a woodland border and as a facer shrub in many landscaping situations.

Several popular landscape and garden manuals show little enthusiasm for the Snowberries, and justifiably so when we see the scraggly performance of the larger garden import, *Symphoricarpos albus* (L.) Blake var. *laevigatus* (Fern.) Blake. This plant comes from the West Coast and occasionally escapes around the Midwest. Variety *laevigatus* often grows to a lanky, arching, five feet in height and while its berries are larger than our native Snowberry, its leaves have no fall color, turning instead a muddy green after a heavy frost. Hence, much like the Old World Honeysuckles (*Lonicera* spp.) and Buckthorns (*Rhamnus* spp.), this introduced Snowberry declares its inappropriateness as an ill-adapted and unbalanced intruder into the ecological systems of the Midwest.

Our Snowberry was first collected in 1977, and it was reported in Plants of the Chicago Region (Swink and Wilhelm 1979). Although this species is not

listed as endangered or threatened in Illinois (Sheviak 1981), it is decidedly rare here in Illinois and has been formally recommended for listing as state endangered or threatened (Marlin Bowles, personal communication). Gleason says of our native species, "Dry or rocky soil Que. to Alaska, and s. to Pa., W. Va., Mich. and Minn. (Including var. *pauciflorus* Robbins) (*S. racemosus*, Gray, B & B)".

Swink and Wilhelm (1979) note a Racine County, Wisconsin, specimen cited by Wade and Wade (1940), and I have seen a number of colonies along Lake Michigan bluffs south of Milwaukee, Wisconsin. These Wisconsin plants closely resemble our own little Mooseheart plants in both form and habit. Plants, of course, do not recognize state borders, and it may well be that there are no great genetic differences between the Wisconsin and Illinois populations. Nonetheless, I am convinced that Illinois' own delightful little Snowberry is well worth the effort needed to preserve it *in situ* for numerous reasons, such as maintenance of native plant biodiversity, evolutionary potential at the edge of the species' range, and many more. Kane County currently has the disquieting distinction of the being the fastest-growing county in Illinois, and like too many other places, there are many parcels of land that need protection before they are irretrievably lost. Fortunately for our Mooseheart Snowberry, there is no money needed for this particular cause, just a willingness to cut brush, and a better understanding of sound ecological management.

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Table 1. Native plant species found in association with Snowberry colony at Mooseheart Ravine, along Mill Creek,
Kane County, Illinois.

Scientific Name	Common Name
Allium tricoccum Ait.	Wild Leek
Amelanchier humilis Wieg.	Low Shadblow
Andropogon gerardi Vitm.	Big Bluestem Grass
Aralia nudicaulis L.	Wild Sarsaparilla
Aster shortii Lindl.	Short's Aster
Carex laxiflora Lam.	Wood Sedge
Desmodium canadense (L.) DC.	Showy Tick Trefoil
Dirca palustris L.	Leatherwood
Elymus villosus Muhl.	Silky Wild Rye
Galium triflorum Michx.	Sweet-scented Bedstraw
Hystrix patula Moench	Bottlebrush Grass
Lonicera prolifera (Kirchn.) Rehd.	Yellow Honeysuckle
Monarda fistulosa L.	Wild Bergamot
Ostrya virginiana (Mill.) K. Koch	Ironwood, Hop Hornbeam
Parthenocissus quinquefolia (L.) Planch.	Virginia Creeper
Polymnia canadensis L.	Leafcup
Quercus alba L.	White Oak
Quercus muhlenbergii Engelm.	Chinquapin Oak
Quercus rubra L.	Red Oak
Ranunculus fascicularis Muhl.	Early Buttercup
Rhus radicans L.	Poison Ivy
Silene stellata (L.) Ait.f.	Starry Campion
Silphium terebinthinaceum Jacq.	Prairie Dock
Smilacina racemosa (L.) Desf.	Feathery False Solomon's Seal
Smilax tamnoides L. var. *hispida* (Muhl.) Fern.	Bristly Green Brier
Solidago flexicaulis L.	Broad-leaved Goldenrod
Solidago ulmifolia Muhl.	Elm-leaved Goldenrod
Tilia americana L.	Basswood, American Linden
Ulmus americana L.	American Elm
Viburnum prunifolium L.	Black Haw
Zizia aptera (Gray) Fern.	Heart-leaved Meadow Parsnip

Forest Glen's Savanna Project

Ken Konsis and Doris Westfall

Forest Glen Chapter
Illinois Native Plant Society
Westville, Illinois 61883

Recently the Forest Glen Chapter of INPS embarked on a new project, a savanna restoration. Forest Glen is an 18000-acre county preserve governed by the Vermilion County Conservation District. One of the reasons behind this endeavor was to educate the public on what may be Illinois' rarest landscape. The problem confronting us is: what does a savanna in east-central Illinois look like?

Our project area consists of 20 acres of advanced secondary succession. The tract borders the 40 acre Doris L. Westfall Prairie Restoration Area in Forest Glen Preserve near Westville, Illinois.

Presently, the savanna site includes 3 old fence rows with large trees present, a small wildlife food plot of native prairie species, a few acres of tall fescue grass (*Festuca pratensis*), a row of autumn olive trees (*Elaeagnus umbellata*), a double row of yellow poplar (*Liriodendron tulipifera*), and sweet gum trees (*Liquidambar styraciflua*) that border the park entrance road, and a small wetland. Today, several management decisions would be more carefully chosen than they were 20 years ago. For instance, tall fescue grass would not have been planted for an erosion control grass. Switch grass (*Panicum virgatum*) would have been planted instead. The autumn olive trees were planted when this tree was accepted as the great savior for restoring wildlife habitat. Now, it is being considered for inclusion on the state's "banned" list of troublesome exotic plant species. The bordering rows of yellow poplar and sweet gum remain justified to enhance the park's entrance, with their pyramidal shape and contrasting fall coloration. District administrators will not justify their removal for this savanna project. A fire lane will be used when burning the savanna.

This area was chosen for at least 3 reasons:

1. PUBLIC VISIBILITY - Everyone entering the park would pass by the savanna project.
2. EXISTING SPECIES - Several oak trees and prairie species are already present.
3. LOCATION - Situated directly east of the Doris L. Westfall Prairie Restoration Area, the savanna should be naturally seeded by the prevailing west winds.

Several problem species exist besides the ones earlier mentioned. They are: multiflora rose, *Rosa multiflora*; tall bush clover, *Lespedeza thunbergii*; silky bush clover, *Lespedeza cuneata*; wild black cherry, *Prunus serotina*; Queen Anne's lace, *Daucus carota*; timothy, *Phleum pratense*; honey locust, *Gleditsia triacanthos*; and hawkweed, *Hieracium* spp.

A rough plan of action was developed and consists of the following:

1. Inventory all existing plant species.
2. Visit a prime black-soil savanna.
3. Section off the area into "working blocks".
4. Determine what species should occur in a savanna for east-central Illinois that are presently found in our project area.
5. Begin management by "bush hog" mowing.
6. Cut larger trees with a chain saw, and chemically treat the stumps.
7. Plow and disk existing block of tall fescue grass.
8. Seed barren areas with prairie species.
9. Possibly transplant larger oak trees, using a Vermeer tree spade.
10. Eventually, use fire as a management tool.

It is our opinion that fire should not be used in the initial management stages because of its detrimental effects toward the young woody savanna species we are trying to save.

A partial list of some of the significant plant species found in this inventory is listed below. Nomenclature follow Mohlenbrock (1986).

TREES

Acer negundo
Acer saccharum
Asimina triloba
Carya ovata
Celtis occidentalis
Cercis canadensis
Cornus florida
Crataegus mollis
Gleditsia triacanthos
Juglans nigra
Juniperus virginiana
Liriodendron tulipifera
Liquidambar styraciflua
Malus ioensis
Prunus americana
Prunus angustifolia
Prunus serotina
Quercus imbricaria
Quercus macrocarpa
Quercus rubra
Rhus glabra
Sassafras albidum
Ulmus rubra

SHRUBS AND BRAMBLES

Cornus drummondii
Cornus racemosa
Corylus americana
Rosa multiflora
Rosa sp.
Rubus allegheniensis
Rubus flagellaris
Rubus occidentalis
Sambucus canadensis

VINES

Celastrus scandens
Menispermum canadense
Parthenocissus quinquefolia
Toxicodendron radicans
Vitis spp.

HERBACEOUS

(Savanna species)
Andropogon gerardii
Asclepias verticillata
Baptisia leucantha
Cassia fasciculata
Coreopsis palmata
Fragaria virginiana
Helianthus grosseserratus
Helianthus mollis
Liatris pycnostachya
Monarda fistulosa
Panicum virgatum
Pycnanthemum tenuifolium
Rudbeckia hirta
Schizachyrium scoparium

(Native but non-savanna)
Aster pilosus
Cystopteris protrusa
Desmodium cuspidatum var. *longifolium*
Desmodium paniculatum
Lysimachia ciliata
Polygonatum commutatum
Solidago altissima
Solidago juncea
Tradescantia subaspera
Verbesina alternifolia
Vernonia missurica

(Eliminate if possible)
Achillea millefolium
Ambrosia trifida
Bromus inermis
Bromus commutatus
Daucus carota
Festuca pratensis
Melilotus alba
Melilotus officinalis
Pastinaca sativa
Phleum pratense
Setaria faberi
Trifolium pratense

CONCLUSION

Hopefully, a few years from now our savanna project will be an accurate representation of a naturally-occurring savanna of east-cental Illinois. Plans also include an interpretive trail. To date, we have inventoried the existing plant species and have visited the Iroquois County Conservation Area several times. Even though the Iroquois area is a sand savanna, we now understand better the make-up of a managed savanna.

ACKNOWLEDGMENTS

We would like to thank Dr. Kenneth Robertson and John Taft of the Illinois Natural History Survey for their help in identifying some of our plant species found in the initial inventory.

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Woody Understory of Baber Woods, Edgar County, Illinois

Jacqueline M. Landes and John E. Ebinger

Botany Department
Eastern Illinois University
Charleston, Illinois 61920

ABSTRACT

The woody understory of Baber Woods Nature Preserve, Edgar County, Illinois, was surveyed in closed and open canopy areas. Data were analyzed for age/height relationships, and the density, frequency, relative density, relative frequency, and importance value were determined for each species. Under the closed canopy seedlings and saplings of slippery elm and sugar maple account for an importance value of 153.7 (out of 200) and a total of 8,478 stems/ha. In open canopy situation these same species dominated, accounting for an importance value of 188.6 with 6,900 stems/ha. If this trend continues, Baber Woods will soon become a sugar maple dominated forest.

INTRODUCTION

Baber Woods Nature Preserve, situated on the northern edge of the Shelbyville Moraine, the terminal moraine of Wisconsin glaciation, is a 16 ha woodlot located 8 km NE of Westfield, Edgar County, Illinois (NW1/4 Sec 18, T12N, R13W). In 1835 the Baber family purchased a section of this woods and by 1894 had obtained the entire area. The woods was acquired by the Nature Conservancy in 1969 and is a dedicated Illinois Nature Preserve. Originally the woodlot was a source of wood for fence-rails, timber, and firewood, but most of the woods were left undisturbed except for a 1 ha lot in the SW corner of the timber that provided space for two cabins. This natural area has a gently rolling topography ranging from 229-242 m above mean sea level, is well-drained except for several small depressions, and contains three small ravines that are dry except immediately after a moderate rain.

White oak savanna dominated the Baber Woods area in presettlement time, and with the exclusion of fire developed into a closed oak-hickory forest (Ebinger and McClain, in press). In the past 35 years sugar maple (*Acer saccchanum* Marsh.) has undergone an explosive increase in importance in this woods. In an inventory of the woody overstory by McClain and Ebinger (1968) sugar maple had an importance value (IV) of 35.7, averaging 66.5 stems/ha (10 cm dbh and above), while in a more recent survey (Newman and Ebinger 1985) the IV of sugar maple had increased to 51.9, with an average of 100.1 stems/ha. These results suggest that sugar maple is replacing oak and hickory as the dominant forest species in Baber Woods, and probably in many central Illinois forests (Ebinger 1986). Furthermore, Runkle (1984) has found that this aggressive species is a very significant part of treefall gaps since it is abundant in many woods as small saplings, and so, is present in most gaps at the time of their formation. It grows fairly rapidly, even in fairly small gaps, due to its ability to grow and form good root systems at low light levels (Logan 1965). The present study was undertaken to determine the present composition and structure of the woody understory in this woods, since management techniques may soon be used to try and increase oak and hickory reproduction.

METHODS AND MATERIALS

Nine 100-m transects were randomly located under the closed canopy throughout the woods, and twenty 25-m transects were located where gaps had occurred in the canopy. Along each transect, continuous 1-m^2 quadrats were placed, and all woody plants with a height of more than 40 cm and a dbh of less than 10 cm were removed. A basal cross section was removed from each specimen and affixed with a label containing the specimen number. The species name, height, and quadrat location were

recorded for each specimen. Diameter and ring number were later recorded for each specimen. Also, the density (stems/ha), frequency, relative density, relative frequency, and importance value were determined for each species (McIntosh 1957, Boggess 1964).

Transects in the closed canopy area of the woods were located so as not to cross any open canopy areas, while in the open canopy areas transects were placed where gaps had occurred in the overstory. Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

A total of nine woody understory species were recorded in the plots. Three of these, *Acer saccharum*, *Ulmus rubra* Muhl. (slippery elm), and *Asimina triloba* (L.) Dunal (pawpaw), were found to have high enough numbers to constitute individual analysis by species. The other six species are identified hereafter as "other" since they do not constitute a significant part of the understory. These species are *Carya cordiformis* (Wang.) K. Koch (bitternut hickory), *Carpinus caroliniana* Walt. (blue beech), *Corylus americana* Walt. (hazelnut), *Morus rubra* L. (red mulberry), Prunus serotina Ehrh. (wild black cherry), and *Fraxinus americana* L. (white ash).

Ulmus rubra was the most common understory species in the closed canopy areas of Baber Woods with an IV of 97.8 (Table 1) and a density of 5,856 (stems/ha) (Table 1). It decreased to second in importance (IV of 94.0) in open canopy areas, averaging 3,620 stems/ha. *Acer saccharum* was also extremely common in both the closed and open canopy areas. Under the closed canopy this species averaged 2,622 stems/ha and had an IV of 55.9, while under open canopy situations it increased to first in importance (IV of 94.6) and averaged 3,280 stems/ha. *Asimina triloba* was relatively important in the closed canopy with an IV of 35.2, declining to 3.8 under an open canopy. The "other" species under the closed canopy had IV's of 11.1, which dropped to 7.6 under the open canopy.

Although the density of sugar maple increases in open canopy areas, there is an overall decrease in density of all species from the closed canopy (11,289 stems/ha) to the open canopy (7,280 stems/ha) (Table 1). An analysis of growth-ring widths indicates that the canopy gaps occurred between 10-25 years ago. The high gap-phase-replacement-potential of sugar maple is probably responsible for this overall decrease in density since the large, fast growing individuals would probably outcompete small individuals and less aggressive species.

An age/height comparison was calculated for all species combined in both the open and closed canopy areas. As expected, the understory woody species growing in the open canopy areas were found to be consistently taller than their closed canopy counterparts of the same age (Fig. 1). Sugar maple, when analyzed separately, has the greatest increase in height, and, theoretically, the greatest growth occurred after a gap opened in the canopy. The ring width of sugar maple specimens taken from the same gap, showed an increase in ring width at approximately the same time in all specimens. These results indicate that sugar maple is a very aggressive species in treefall gap situations. Slippery elm, in contrast, has a low gap-phase-replacement-potential and is easily crowded out by sugar maple.

Although Baber Woods still contains many large oak and hickory trees, the present study indicates that they are not reproducing. No oak seedlings (greater than 40 cm in height) or saplings were found in the transects, and, of the hickory species present, only bitternut hickory was recorded in the transects, and only in very low numbers. The present data also suggest that sugar maple is an aggressive species that will replace the oaks and hickories as the veteran trees die. If this trend continues, Baber Woods will become a sugar maple forest within 40 to 50 years. In contrast, slippery elm, which has potential canopy status and is certainly dominant in the understory, is prevented from realizing its full height potential due to Dutch elm disease and its low gap-phase-replacement-potential.

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Table 1. Density (stems/ha), frequency, and relative values for the woody understory species of the closed and open canopy areas of Baber Woods Nature Preserve, Edgar County, Illinois.

Species	Stems/ha	Freq. (%)	Rel. Den.	Rel. Freq.	IV
Closed Canopy					
Ulmus rubra	5856	30.6	51.9	45.9	97.8
Acer saccharum	2622	21.7	23.2	32.7	55.9
Asimina triloba	2311	9.7	20.5	14.7	35.2
Other species	500	---	4.4	6.7	11.1
Totals	11,289	---	100.0	100.0	200.0
Open Canopy					
Acer saccharum	3280	27.4	45.1	49.5	94.6
Ulmus rubra	3620	24.6	49.7	44.3	94.0
Asimina triloba	120	1.2	1.6	2.2	3.8
Other species	260	---	3.6	4.0	7.6
Totals	7280	---	100.0	100.0	200.0

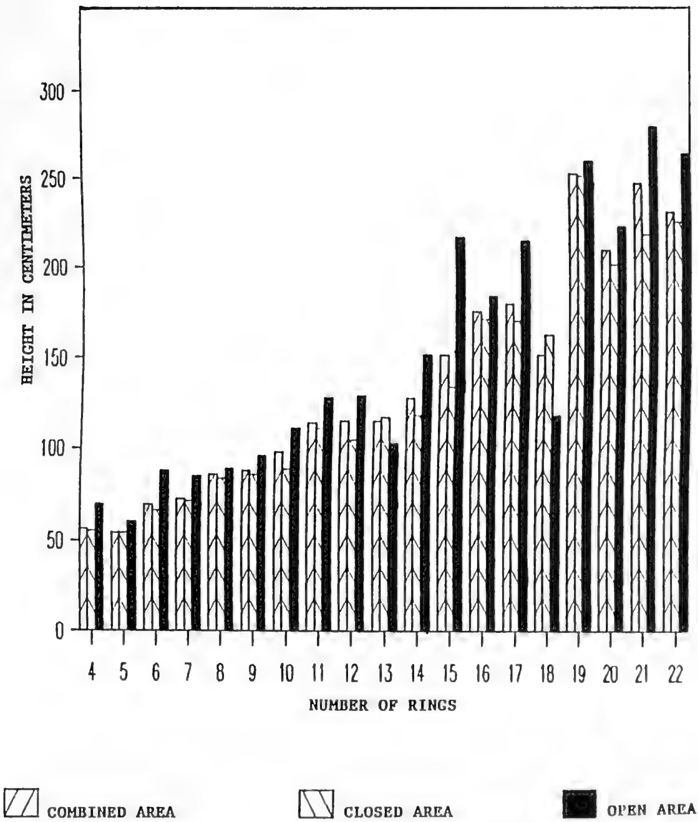

Figure 1. Age/height comparison of all woody understory species in open and closed canopy areas at Baber Woods Nature Preserve, Edgar County, Illinois.

Vegetation of Wolf Creek State Park, Shelby County, Illinois

Shaun A. Newell, Lucinda L. Horton, and John E. Ebinger

Botany Department
Eastern Illinois University
Charleston, Illinois 61920

ABSTRACT

The woody overstory of four forest types was surveyed at Wolf Creek State Park, Shelby County, Illinois. These included: a successional upland forest (592 stems/ha and a basal area of 15.41 m^2/ha), an immature second growth upland forest (426 stems/ha and a basal area of 22.21 m^2/ha), a mature second growth upland forest (292 stems/ha and a basal area of 26.39 m^2/ha), and a mature second growth ravine forest (362 stems/ha and a basal area of 23.29 m^2/ha).

INTRODUCTION

Wolf Creek State Park is located about 8 miles northwest of Windsor, Shelby County, Illinois in the Kaskaskia River Basin (parts of Sections 6, 7, 17, 18, 19 T12N R5E and Sections 24, 25 T12N R4E). The park, 791 ha in size with Lake Shelbyville surrounding it on three sides, is located in the Grand Prairie Division (Schwegman 1973) about 5 miles north of the Shelbyville Moraine, the terminal moraine of Wisconsin glaciation. Most of the park is flat to gently sloping uplands with a few steep, wooded slopes at the margin of the lake. Before being purchased for a park in 1968, most of the flat uplands were cultivated or grazed. Most of this formerly cultivated land is presently in the perennial herb stage of succession, while most of the sloping ground is covered with immature to relatively mature second growth forest. The present study was undertaken to determine the composition of the forest types that currently exist in the park.

MATERIALS AND METHODS

All forest areas studied were divided into quadrats 25 m on a side, with a total of eight contiguous quadrats in each area, and the number, diameter at breast height (dbh), and species of all living trees above 10 cm dbh were recorded for each quadrat. Importance values (IV) were then calculated for each species in each of the areas sampled. Determination of the IV follows the procedure developed by McIntosh (1957), and later Boggess (1964), in which the IV is the sum of the relative density and relative dominance. Also, determined for each species is the density (#/ha) in broad diameter classes and the basal area (m^2/ha). In each of the quadrats, a 0.01 ha circular plot was located randomly in which saplings (2.5-10.0 cm dbh) were recorded as to their species and density (stems/ha). Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

Mainly due to part human activities, most central Illinois forests have been destroyed or extensively modified. As a result, few forested areas, except heavily degraded ones, occur within the boundary of Wolf Creek State Park. During the present study, examples of each the common forest types in the park were surveyed. For each of the four forest types, the common canopy tree species are listed in Tables 1 through 4 along with their densities (stems/ha) in broad diameter classes, basal area (m^2/ha), relative values, importance values, and average diameters.

<u>Successional Upland Forest:</u> This relatively common forest type occurs on areas that were probably abandoned pastures or abandoned cultivated fields before the land was purchased for a park. In this forest type, the average number of individuals per ha is 592, while the basal area averages 15.41 m^2/ha (Table 1). *Ulmus americana* L. (American elm) is the dominant species with numerous individuals in the sapling and 1-2 dm diameter class, an average of 208 stems/ha, a basal area of 4.14 m^2/ha, and an IV

of 61.7. *Juglans nigra* L. (black walnut) and *Gleditsia triacanthos* L. (honey locust) are also common components, both of which have numerous individuals in the sapling and lower diameter classes. Black walnut also has the highest basal area (4.35 m^2/ha) and the largest average diameter (20.3 cm). Numerous other successional tree species are also present, with *Prunus serotina* Ehrh. (black cherry), *Acer negundo* L. (box elder), *Crataegus mollis* (T. & G.) Scheele (red haw), and *Celtis occidentalis* L. (hackberry) being relatively common in the sapling and lowest diameter class. Species in the "others" category of Table 1 include *Carya ovata* (Mill.) K. Koch (shagbark hickory), *Diospyros virginiana* L. (persimmon), *Morus rubra* L. (red mulberry), *Sassafras albidum* (Nutt.) Nees (sassafras), *Ulmus rubra* Muhl. (slippery elm), and *Malus ioensis* (Wood) Britt. (Iowa crabapple).

Immature Second Growth Upland Forest: This forest type, located on the flat uplands, is the most common forest type. Before the land was purchased for a park, this forest type was heavily grazed. The average number of individuals per ha is 426, while the basal area averages 22.21 m^2/ha (Table 2). Shagbark hickory is the dominant species, being common in the lower diameter classes with 166 individuals per ha, an IV of 61.1, and the highest relative density. *Quercus alba* L. (white oak) is second in IV (42.3), and is represented in all diameter classes. Other common forest components include *Quercus velutina* Lam. (black oak) and *Q. imbricaria* Michx. (shingle oak), both of which have numerous individuals in the larger diameter classes. Black oak has the highest basal area (5.90 m^2/ha) and the largest average diameter (33.8 cm). *Fraxinus americana* L. (white ash), though not common in the overstory (IV of 7.0), is well represented in the sapling layer. Other woody species present are not common components of the overstory having IV's of 5.0 or less. Species in the "others" category of Table 2 include black cherry, slippery elm, sassafras, red mulberry, hackberry, and *Ostrya virginiana* (Mill.) K. Koch (hop hornbeam). In this woodlot the oaks and hickories are not common in the sapling layer. In contrast, white ash, slippery elm, American elm, sassafras, black cherry, and hop hornbeam dominate the woody understory. In the future, some of these latter species will probably increase in importance.

Mature Second Growth Upland Forest: Only one small 6 ha woodlot of this forest type was found in the park. It had been lightly grazed in the past, but has not been subjected to logging for more than 40 years. In this woodlot, the average number of individuals per ha is 292, while the basal area is the highest of the forests studied (26.39 m^2/ha) (Table 3). White oak is the dominant species, averaging 130 individuals per ha, with an IV of 122.1, a basal area of 20.49 m^2/ha, and the most individuals in the 30-40 and 40+ dm diameter classes. *Acer saccharum* Marsh. (sugar maple), which is second in IV (23.3), is represented only in the sapling and smallest diameter class (10-20 dm). Other common forest components include two hickory species. *Carya glabra* (Mill.) Sweet (pignut hickory) is second in basal area (3.12 m^2/ha), has an IV of 20.7, and mostly occurs in the larger diameter classes; while shagbark hickory ranks fourth in IV (10.1), with most of the individuals in the 10-20 dm diameter class. The other tree species encountered are not common components of this forest, and, except for black walnut, are found mostly in the 10-20 dm diameter class. The species in the "others" category of Table 3 include hackberry, Iowa crabapple, and *Carya cordiformis* (Wang.) K. Koch (bitternut hickory).

White oak and pignut hickory are not well represented in the sapling layer. In contrast, sugar maple, white ash, black cherry, slippery elm, and shagbark hickory dominate the understory. In the future, sugar maple will most likely become the dominant species of both the overstory and understory as the veteran oaks and hickories die. Its high gap-phase-replacement potential will insure its continued dominance in the forest (Ebinger 1986).

Mature Second Growth Ravine Forest: This forest type is found in a relatively narrow ravine next to the mature second growth upland forest. In this forest the average number of individuals per ha is 362, while the basal area averages 23.29 m^2/ha (Table 4). White oak is the dominant species in this forest type (IV of 62.7) followed by sugar maple and *Quercus rubra* L. (red oak), with IV's of 53.4 and 46.9, respectively. Both oak species are common in the higher diameter classes, have few saplings present, and average diameters in excess of 36 cm. Sugar maple, in contrast, averages 375 saplings per ha, is common only in the lower diameter classes, and has an average diameter of 13.6 cm. The other

tree species are relatively minor components in the woodlot, with only pignut hickory (IV of 14.0) and shagbark hickory (IV of 11.5) having importance valves greater than 10. The species in the "others" category of Table 4 include American elm, bitternut hickory, and *Cercis canadensis* L. (redbud).

The oaks and hickories are poorly represented in the understory of this ravine. In contrast, sugar maple, American elm, and black cherry account for nearly 90% of the individuals in the sapling category. Based on the number of individuals of sugar maple in the smaller diameter classes, it is very likely that this species will soon dominate the woodlot.

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Table 1. Diameter classes, basal areas, relative values, importance values, and average diameters of the woody species in a successional upland forest at Wolf Creek State Park, Shelby County, Illinois.

Species	Saplings Ind/ha	Diameter Class (dm) stems/ha 1-2	2-3	3-4	4+	Total	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	IV	Av. Diam. cm
Ulmus americana	250	180	28	-	-	208	4.14	35.0	26.7	61.7	15.3
Juglans nigra	150	60	52	8	-	120	4.35	20.2	28.2	48.4	20.3
Gleditsia triacanthos	25	48	28	4	4	84	2.99	14.2	19.4	33.6	19.8
Prunus serotina	25	20	8	4	-	32	1.12	5.4	7.3	12.7	20.2
Acer negundo	-	24	8	-	-	32	0.68	5.4	4.4	9.8	15.9
Quercus velutina	-	16	4	4	-	24	0.72	4.1	4.7	8.8	18.2
Crataegus mollis	100	32	-	-	-	32	0.37	5.4	2.4	7.8	12.0
Celtis occidentalis	25	20	4	-	-	24	0.47	4.1	3.1	7.2	15.5
Others (6 species)	175	36	-	-	-	36	0.57	6.2	3.8	10.0	-
Totals	750	436	132	20	4	592	15.41	100.0	100.0	200.0	

Table 2. Diameter classes, basal areas, relative values, importance values, and average diameters of the woody species in an immature second growth upland forest at Wolf Creek State Park, Shelby County, Illinois.

Species	Saplings Ind/ha	Diameter Class (dm) stems/ha 1-2	2-3	3-4	4+	Total	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	IV	Av. Diam. cm
Carya ovata	13	102	58	6	-	166	4.90	39.0	22.1	61.1	18.6
Quercus alba	-	18	38	24	2	82	5.13	19.2	23.1	42.3	26.9
Quercus velutina	-	-	10	46	8	64	5.90	15.0	26.6	41.6	33.8
Quercus imbricaria	-	-	56	20	2	78	4.87	18.3	21.9	40.2	27.7
Fraxinus americana	400	6	4	-	4	14	0.83	3.3	3.7	7.0	24.5
Carya tomentosa	13	10	2	2	-	14	0.38	3.3	1.7	5.0	17.2
Ulmus americana	63	4	2	-	-	6	0.17	1.4	0.8	2.2	18.6
Acer saccharum	13	2	-	-	-	2	0.03	0.5	0.1	0.6	13.3
Others (6 species)	577	-	-	-	-	-	-	-	-	-	-
Totals	1079	142	170	98	16	426	22.21	100.0	100.0	200.0	

Table 3. Diameter classes, basal areas, relative values, importance values, and average diameters of the woody species in mature second growth upland forest at Wolf Creek State Park, Shelby County, Illinois.

Species	Saplings Ind/ha	Diameter Class (dm) stems/ha 1-2	2-3	3-4	4+	Total	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	IV	Av. Diam. cm
Quercus alba	-	2	12	30	86	130	20.49	44.5	77.6	122.1	43.8
Acer saccharum	263	60	-	-	-	60	0.74	20.5	2.8	23.3	12.4
Carya glabra	-	4	2	10	10	26	3.12	8.9	11.8	20.7	37.4
Carya ovata	63	20	2	2	-	24	0.49	8.2	1.9	10.1	14.9
Juglans nigra	-	-	2	4	2	8	0.91	2.7	3.4	6.1	36.9
Ulmus rubra	88	14	-	-	-	14	0.15	4.8	0.6	5.4	11.4
Fraxinus americana	113	12	-	-	-	12	0.15	4.1	0.6	4.7	12.6
Carya tomentosa	13	2	4	-	-	6	0.17	2.1	0.6	2.7	18.9
Prunus serotina	250	6	-	-	-	6	0.06	2.1	0.2	2.3	11.1
Others (3 species)	25	6	-	-	-	6	0.11	2.1	0.5	2.6	-
Totals	815	126	22	46	98	292	26.39	100.0	100.0	200.0	

Table 4. Diameter classes, basal areas, relative values, importance values, and average diameters of the woody species in a mature second growth ravine forest at Wolf Creek State Park, Shelby County, Illinois.

Species	Saplings Ind/ha	Diameter Class (dm) stems/ha 1-2	2-3	3-4	4+	Total	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	IV	Av. Diam. cm
Quercus alba	-	6	18	30	30	84	9.19	23.2	39.5	62.7	36.2
Acer saccharum	375	146	10	-	-	156	2.42	43.0	10.4	53.4	13.6
Quercus rubra	13	-	4	12	32	48	7.82	13.3	33.6	46.9	44.3
Carya glabra	13	-	4	8	6	18	2.10	5.0	9.0	14.0	37.8
Carya ovata	-	14	8	4	-	26	1.01	7.2	4.3	11.5	20.9
Prunus serotina	75	12	-	-	-	12	0.19	3.3	0.8	4.1	14.1
Fraxinus americana	25	10	-	-	-	10	0.18	2.8	0.8	3.6	14.9
Others (3 species)	101	4	2	2	-	8	0.38	2.2	1.6	3.8	-
Totals	602	192	46	56	68	362	23.29	100.0	100.0	200.0	

Rarely Seen Endangered Plants, Rediscoveries, and Species New to Illinois

Marlin L. Bowles[1], John B. Taft, Eric F. Ulaszek, Mary Kay Solecki[2], David M. Ketzner, Loy R. Phillippe, Ann Dennis, Philip J. Burton[3], and Kenneth R. Robertson

Illinois Natural History Survey
607 E. Peabody Drive
Champaign, IL 61820

[1] The Morton Arboretum, Lisle, IL 60532
[2] Current address: Illinois Nature Preserves Commission, P.O. Box 497, Sidney, IL 61877
[3] Current address: University of British Columbia, 270-2357 Main Mall, Vancouver, B.C. V6T 1W5

INTRODUCTION

About 17% of the vascular plant species native to Illinois are officially listed as state-threatened or endangered. The original 1980 list (Sheviak 1981) included 312 endangered and 52 threatened species of vascular plants; the current list, revised in 1990 (Illinois Endangered Species Protection Board 1990), includes 296 endangered and 60 threatened species. Some species were included in these lists, based on historical herbarium records, but living populations were not known to occur in Illinois or were known from only one or a few locations. During 1987 and 1988, the authors undertook a project to review the status and to locate populations of 137 of these extremely rare species. In 1987, our emphasis was on locating species for which no extant populations were known. In 1988, our efforts concentrated on species not found during 1987 and on species for which only a few extant populations were known. Fieldwork focused on those species considered most likely to be extant or to be most critical on state and national levels. The results were submitted as unpublished reports to the Illinois Endangered Species Protection Board (Bowles *et al.* 1988, Bowles *et al.* 1989). Because those reports are not readily accessible, the information they contain is presented here.

METHODS

Locations where the 137 selected species had been collected or observed historically were obtained from herbarium data compiled by the Natural Land Institute in 1977 during preparation of the original list of endangered and threatened species. Files compiled by the Illinois Natural Areas Inventory during 1975-1978 and maintained since by the Illinois Department of Conservation Natural Heritage Division were also consulted extensively, as were personal contacts and notebooks of original collectors. We used this information to direct field searches. Because some location information is vague, especially for older records, we could not always determine exact historical locations, and field searches often required additional time and knowledge of local habitat and species ecology. In the course of these studies, we found it necessary to investigate the taxonomy and nomenclature of several species.

For each species in this report, we list two categories of distribution records: 1) the Illinois counties for which voucher specimens are known to exist (Known specimens), and 2) other Illinois counties where the species has been reported to occur, but for which we could not confirm the existence of specimens (Other reports). The second category includes cases in which we could find no record of herbarium deposition or private possession for specimens cited in the literature. Specimens recorded in herbarium holdings but not found in the cabinets are included in the first category and noted "specimen missing". For some species we list a third category of distribution records: 3) counties for which all reported occurrences of the species have been found to be in error (Erroneous reports). We note in each case whether the error is due to misidentification of specimens or to errors in published distribution maps. We have attempted to account for all counties indicated on distribution maps in <u>Endangered and Threatened Plants</u> (Sheviak

1981), Distribution of Illinois Vascular Plants (Mohlenbrock and Ladd 1978), and Vascular Plants of Illinois (Jones and Fuller 1955).

For all species, we report the county and year of the last known Illinois collection prior to the publication of Endangered and Threatened Plants (Sheviak 1981). Full citations for any subsequent collections or documented sightings are included in discussions of current population status. When recent collections represent new county records, these are noted as "new" in the distribution entries.

Nomenclature follows that used by Sheviak (1981) and the Illinois Endangered Species Protection Board (1990). Synonyms are noted when this nomenclature differs from that used in Kartesz and Kartesz (1980). Nomenclature used in Mohlenbrock (1986) is noted when it differs from both of these. These synonyms are indicated by K&K and RHM, respectively.

Abbreviations for herbaria cited are: DEK (Northern Illinois University), DOC (Illinois Department of Conservation), F (Field Museum of Natural History), GH (Gray Herbarium of Harvard University), ILL (University of Illinois at Urbana/Champaign), ILLS (Illinois Natural History Survey), ISM (Illinois State Museum), MOR (Morton Arboretum), NY (New York Botanical Garden), SIU (Southern Illinois University at Carbondale), and MWI (Western Illinois University).

RESULTS

In the course of this study, we found or received documented reports of extant populations of 57 species; 71 of the species included in the search were not found (Table 1). Of those not found, 49 may still occur and should be looked for in subsequent years, but the remaining 22 appear to be extirpated from Illinois. Dry conditions during parts of 1987 and the drought of 1988 may well have kept some species from appearing. While conducting fieldwork for this and other projects, 3 species new to Illinois were discovered and are included here since they have been added to the list of endangered species.

In seven cases, we found all Illinois specimens of the species in question to have been incorrectly identified; these specimens are now annotated as species which are not threatened or endangered in Illinois. One of the species included in this report, *Valerianella intermedia*, is no longer considered valid, but is accepted as synonymous with *Valerianella umbilicata*, which remains listed as endangered in Illinois. Some controversy surrounds another species included here, *Aristida necopina*. Issues of both identification and taxonomic distinction will have to be resolved before we can determine if it now occurs, or ever did occur, in Illinois.

Adoxa moschatellina L.
Known specimens: Jo Daviess
Other reports: none
Last historic collection: 1937 Jo Daviess

This species is known historically in Illinois from one locality in Jo Daviess Co. It was discovered on a mesic floodplain terrace in 1983 (Sorensen, Bowles, and Nyboer 8375, DEK) in the general vicinity of the original collections.

Amorpha nitens Boynton
Known specimens: Pope
Other reports: none
Last historic collection: 1923 Pope

This species was presumed to be extirpated from Illinois following unsuccessful searches in 1987 of the original collection locality and of another Pope Co. site where it had been reported to occur. In 1988, one population of about 100 plants was found in Pope Co. (Taft 504-507, 511, 524, ILLS).

Apios priceana B.L. Robinson
Known specimens: Union
Other reports: none
Last historic collection: 1941 Union

There is only one valid Illinois collection of this species (Fuller 664, ILLS, ILL, ISM, 1941). The other collection ascribed to this taxon (Winterringer 2492, ISM, ILL, 1949) is a misidentification (M. Woods pers. comm.), and the occurrence reported by Biotic Consultants (1976) is apparently in error (R.H. Mohlenbrock pers. comm.). The original collection location cannot be precisely determined, but repeated searches have been made of suitable habitat in the vicinity. The plant has not been found, but the possibility remains that it could have been overlooked.

Table 1. Summary of search results for species included in this report.
Column designations:
1 - Species found new to Illinois
2 - Species found in recent searches (since 1981).
3 - Species not found in recent searches, but which may still occur in Illinois.
4 - Species not found in recent searches and presumed extirpated from Illinois.
5 - Species no longer considered valid, or with Illinois occurrence based on misidentification.

	1	2	3	4	5
Adoxa moschatellina		X			
Amorpha nitens		X			
Apios priceana			X		
Aralia hispida			X		
Aristida necopina					X*
Asclepias ovalifolia		X			
Bacopa acuminata				X	
Baptisia tinctoria				X	
Bartonia paniculata			X		
Bidens beckii			X		
Botrychium simplex			X		
Carex atherodes		X			
Carex aurea		X			
Carex austrina		X			
Carex canescens var. disjuncta	X				
Carex chordorrhiza		X			
Carex cumulata				X	
Carex decomposita		X			
Carex disperma		X			
Carex echinata	X				
Carex garberi		X			
Carex intumescens		X			
Carex nigromarginata			X		
Carex oxylepis		X			
Carex pallescens			X		
Carex plantaginea				X	
Carex rostrata		X			
Carex striatula			X		
Carex tonsa		X			
Carex willdenowii		X			
Carex woodii		X			
Chimaphila maculata			X		
Chimaphila umbellata		X			
Cinna latifolia				X	
Conioselinum chinense		X			
Corydalis aurea		X			
Corydalis sempervirens		X			
Cynosciadium digitatum			X		
Cypripedium acaule			X		

	1	2	3	4	5
Daucus pusillus				X	
Eleocharis equisetoides				X	
Eleocharis olivacea		X			
Eleocharis parvula			X		
Equisetum palustre				X	
Equisetum sylvaticum	X				
Eriophorum viridi-carinatum			X		
Euphorbia spathulata		X			
Fuirena scirpoides				X	
Gaultheria procumbens		X			
Geranium bicknellii			X		
Geum rivale				X	
Glyceria arkansana		X			
Glyceria borealis			X		
Glyceria canadensis				X	
Gnaphalium macounii				X	
Habenaria hookeri				X	
Hackelia americana		X			
Helianthus giganteus		X			
Heteranthera reniformis		X			
Hymenoxys acaulis var. glabra				X	
Hypericum boreale					X
Hypericum densiflorum			X		
Juncus vaseyi		X			
Justicia ovata		X			
Lactuca ludoviciana			X		
Lathyrus maritimus			X		
Lipocarpha maculata			X		
Lycopodium inundatum		X			
Medeola virginiana		X			
Melampyrum lineare			X		
Panicum boreale		X			
Panicum columbianum		X			
Panicum hians					X
Panicum longifolium			X		
Panicum nitidum			X		
Panicum ravenelii		X			
Panicum stipitatum		X			
Paspalum bushii		X			

Table 1 continued on next page

Table 1 continued.

	1	2	3	4	5
Paspalum dissectum		X			
Paspalum lentiferum				X	
Phacelia gilioides			X		
Phlox carolina ssp. angusta				X	
Phlox pilosa ssp. sangamonensis		X			
Physostegia intermedia					X
Plantago heterophylla				X	
Poa wolfii		X			
Polygonum bicorne		X			
Potamogeton gramineus		X			
Potamogeton praelongus			X		
Potamogeton pulcher			X		
Potamogeton robbinsii		X			
Potamogeton strictifolius			X		
Potamogeton vaseyi				X	
Potentilla millegrana			X		
Ptilimnium nuttallii		X			
Puccinellia pallida		X			
Pycnanthemum albescens			X		
Pyrola americana			X		
Pyrola secunda					X
Ranunculus ambigens				X	
Ranunculus cymbalaria		X			
Rhamnus alnifolia		X			
Rhynchospora globularis			X		
Rhynchospora macrostachya					X
Rorippa truncata			X		
Rumex hastatulus			X		
Salix serissima			X		
Salix syrticola		X			
Scheuchzeria palustris			X		
Schizachne purpurascens		X			
Scirpus hattorianus			X		
Scirpus microcarpus				X	
Scirpus pedicellatus				X	
Scirpus purshianus			X		
Scirpus smithii			X		
Scirpus torreyi			X		
Scirpus verecundus			X		
Scleria reticularis			X		
Shepherdia canadensis			X		
Sisyrinchium montanum		X			
Solidago arguta			X		
Solidago remota					X
Sorbus americana		X			
Sparganium americanum		X			
Sphaeralcea angusta			X		
Spiranthes lucida			X		
Spiranthes romanzoffiana			X		
Stachys clingmanii					X
Thismia americana			X		
Tradescantia bracteata		X			
Triadenum virginicum			X		
Trillium cernuum			X		
Trillium cuneatum		X			
Vaccinium stamineum			X		
Valerianella intermedia					X
Valerianella umbilicata		X			
Veronica americana		X			
Viola incognita		X			
Viola viarum		X			
Woodwardia virginica				X	

*Taxonomic issues remain unresolved.

Aralia hispida Ventenat
Known specimens: Cook, Lake
Other reports: none
Last historic collection: 1942 Lake

This plant has not been rediscovered despite an extensive survey of the Lake Co. collection vicinity (Sheviak and Haney 1973). Although it is possible that *Aralia hispida* might appear under prescribed burning of suitable sites in Cook Co., this has not yet occurred. This species has probably been extirpated from Illinois.

Aristida necopina Shinners [K&K: *A. glauca* (Nees) Walpers]
Known specimens: Lee
Other reports: none
Last historic collection: 1935 Lee

The only Illinois record for this species is the type collection. The site, described as sandy ridges near ponds in Lee Co., has not been relocated. Shinners (1954) described *A. necopina*, distinguishing it from *A. longespica* Poiret var. *geniculata* (Rafinesque) Fernald. He considered the distinction between *A. intermedia* Scribner and Ball and *A. longespica* var. *geniculata* made in earlier treatments (e.g. Fernald 1950, Gleason 1952) to be invalid and accepted only the latter name, an interpretation supported by Gould (1975). Steyermark (1963), on the other hand, retained the earlier treatment of *A. longespica* var. *geniculata* and *A. intermedia*, and placed *A. necopina* in synonymy with *A. intermedia*. Kartesz and Kartesz (1980) followed Shinners' treatment of these taxa, except that they recognized *A. necopina* as *A. glauca* (Nees) Walpers. Mohlenbrock (1973, 1986) was alone in recognizing three taxa: *A. intermedia*, *A. longespica* var. *geniculata*, and *A. necopina* (as *A. glauca* in 1986).

A. glauca is a perennial of the *A. purpurea* complex (Hitchcock 1950, Gould 1975), while *A. necopina*, regardless of taxonomic status, is an annual of the *A. longespica* complex. There is no evidence that *A. glauca* or any other member of the *A. purpurea* complex occurs in Illinois. We reject the placement of *A. necopina* in synonymy with *A. glauca*, and defer judgment on both the taxonomic validity of *A. necopina* and its occurrence in Illinois until further work has been done on the *A. longespica* complex. If it is found, as Shinners suggested, that *A. necopina* is the valid name for much of the material we now consider to be *A. intermedia*, *A. necopina* would still be rare in Illinois, though possibly not threatened or endangered.

Asclepias ovalifolia Decaisne
Known specimens: Cook, Kendall, Lake, McHenry
Other reports: Kankakee
Last historic collection: 1935 Kendall

This species was recently rediscovered in mesic prairie in Cook Co. (Packard photograph, MOR, 1987), where it had last been collected in 1877.

Bacopa acuminata (Walter) B.L. Robinson [K&K: *Mecardonia acuminata* (Walter) Small]
Known specimens: Wabash
Other reports: none
Last historic collection: 1965 Wabash

This species is known from three Wabash Co. collections, all from one roadside ditch. It was not found during the 1987 search of that site and may have been adventive there.

Baptisia tinctoria (L.) R. Brown
Known specimens: 'North Illinois', believed to be Cook
Other reports: none
Erroneous reports: Marion (misidentification)
Last historic collection: no date Cook

The only valid records of this species are pre-1900 collections from the Chicago region. The original collection sites could not be identified from the vague descriptions given, but potential habitat in the general vicinity was searched. The species was not found and probably no longer occurs in Illinois.

Bartonia paniculata (Michaux) Muhlenberg
Known specimens: Pope
Other reports: none
Erroneous reports: Johnson
Last historic collection: 1967 Pope

A search was not conducted in 1988 for this annual-biennial species due to severe effects of drought. However, the Pope Co. collection site is still intact, and this species may still occur in Illinois.

Bidens beckii Torrey [K&K: *Megalodonta beckii* (Torrey ex Sprengel) Greene]
Known specimens: Cook, Lake
Other reports: none
Erroneous reports: St. Clair (map error)
Last historic collection: 1966 Lake

During 1987 and 1988 this aquatic species could

not be found at the only site where it has been collected in this century. However, it was discovered in 1990 in a second Lake Co. site (Wilhelm 18422 MOR), and it may remain extant in other glacial lakes in Lake Co.

Botrychium simplex E. Hitchcock
Known specimens: Cook, Lee, Winnebago
Other reports: none
Last historic collection: 1975 Cook

Although this species was not relocated in 1988 searches of sites where it had previously been collected, it is opportunistic in successional habitats and could recur in northern Illinois.

Carex atherodes Sprengel
Known specimens: Champaign, Menard, Ogle, Richland, Winnebago (new: Du Page, Grundy, Kane, Lake, McHenry, Shelby, Will)
Other reports: Cook, Hancock, St. Clair
Erroneous reports: Stark (misidentification)
Last historic collection: 1954, Ogle and Winnebago

Prior to 1981, the only historic collection sites thought possibly to support populations of this sedge were in Winnebago and Ogle counties (Sheviak 1981). Since then, it has been rediscovered at one of the Winnebago Co. sites, and found at new locations in Du Page, Grundy, Kane, Lake, McHenry, Shelby, and Will counties, with thirty-six or more populations now known (Bowles 1988). This species has nevertheless been recommended for retention on the State list with 'threatened' status because of continued impacts to its wetland habitat.

Carex aurea Nuttall
Known specimens: Cook, Lake, Menard (new: Kane)
Other reports: none
Last historic collection: 1944 Lake

In 1987, this species was found in a search of beach swales bordering Lake Michigan (Lake Co.: Bowles 676, MOR) in the general vicinity where it had been last collected. It was also collected in 1987 from along Lake Michigan in Cook Co. (Evert 11895 MOR), and subsequently from a calcareous fen in Kane Co. (Young *s.n.*, MOR, 1988).

Carex austrina (Small) Mackenzie
Known specimens: Macon, Perry (specimen missing: Jackson)
Other reports: Monroe
Last historic collection: 1958 Perry

In 1988, this sedge was found (Ulaszek 1347, ILLS) at the Perry Co. site where it had been collected previously. This site is a degraded prairie remnant in an abandoned railroad right-of-way and will probably be converted to cropland in the near future. The specimen for the original Perry Co. collection is missing from the SIU herbarium. This species was not found at one of the two Jackson Co. sites where it has been recorded, and the specimen from that site could not be relocated at SIU for verification. The specimen from the other Jackson Co. site was found to be *C. muhlenbergii* Willdenow var. *enervis* Boott. *C. austrina* is often considered a variety of *C. muhlenbergii* Willdenow (Gleason, 1952). Examination of Illinois collections of *C. muhlenbergii* may reveal specimens of *C. austrina* which have been overlooked.

Carex canescens L. var. ***disjuncta*** Fernald
Known specimens: Lake
Other reports: none
Erroneous reports: La Salle (misidentification)
Last historic collection: 1948 Lake

In 1988, this sedge was discovered in a Lake Co. bog (Taft and Solecki 2322, 2323, ILLS). This species closely resembles *Carex brunnescens* (Persoon) Poiret, another sedge recently reported from Illinois (Taft and Solecki 1987). During this study, two 1948 Lake Co. collections originally identified as *C. brunnescens* (Evers 10338, 10342, ILLS) were determined to be *C. canescens* var. *disjuncta*.

Carex chordorrhiza L.f.
Known specimens: Lake, McHenry
Other reports: none
Last historic collection: 1905 Lake

This species was considered extirpated from Illinois until 1988, when it was rediscovered from a sphagnum bog in Lake Co. (Wilhelm 16295, MOR).

Carex cumulata (Bailey) Fernald
Known specimens: Kankakee
Other reports: none
Last historic collection: 1940 Kankakee

This sedge is represented in Illinois by a single Kankakee Co. collection for which there is no specific location data. It was not found in potential habitat in the general area of the original collection and is probably extirpated from the state.

Carex decomposita Muhlenberg
Known specimens: Union
Other reports: Gallatin, Johnson, Pulaski
Last historic collection: 1969 Union

In 1988, this species was found at one site in Union Co. (Phillippe 13200, ILLS). Although its normal habit is to form clumps on decaying logs, several of the plants found were growing on a roadside embankment. No search was made for the populations reported from Gallatin, Johnson, or Pulaski counties.

Carex disperma Dewey
Known specimens: Kane, Lake
Other reports: none
Last historic collection: 1952 Lake

This sedge was known from two bogs in Lake Co. and from "low ground" in Kane Co. This sedge was rediscovered in a Lake Co. bog in 1988 (Solecki and Taft 2324, 2325, ILLS).

Carex echinata Murray
Known specimens: (new: Winnebago)
Other reports: Lake
Last historic collection: new to Illinois

This sedge was not verified from Illinois until recently, when it was collected from a sedge meadow in Winnebago Co. (Jones and Bowles 762, MOR, 1988, identified by A.A. Reznicek). One earlier record from Lake Co. (Steyermark 63741, F, 1942) was mapped for Illinois (Reznicek and Ball 1980). However, this specimen has abnormally small perigynia and may be introgressant. Location descriptions for earlier Vasey collections of this species are too vague to substantiate that they were made in Illinois (A.A. Reznicek pers. comm.).

Carex garberi Fernald
Known specimens: Cook, Lake
Other reports: none
Last historic collection: 1960 Lake

This species is known from calcareous beach swales near Lake Michigan. It has been re-collected in both Cook (Sorensen 8232, DEK, 1982) and Lake (Bowles 675, MOR, 1987) counties.

Carex intumescens Rudge
Known specimens: Adams, Alexander, Cook, Johnson, Massac, Menard
Other reports: Hancock, Peoria
Erroneous reports: Jersey, Livingston, St. Clair (misidentifications)
Last historic collection: 1971 Alexander

This species was found at two new locations, both in the vicinity of a previous Johnson Co. collection site (Ketzner 1092, ILLS, 1987; Ketzner 1166, ILLS, 1988). No visits were made to collection sites in other counties.

Carex nigromarginata Schweinitz
Known specimens: (specimen missing: Pope)
Other reports: Jackson, Wabash
Last historic collection: (1966 Pope)

A field search of the only site where this species is known to have been collected in Illinois was unsuccessful. However, severe drought had produced poor conditions for observing many sedges, and it is not unlikely that this species was overlooked. The voucher specimen for this Pope Co. collection could not be located at SIU. Sites in Jackson and Wabash counties where this species has been reported to occur were not searched.

Carex oxylepis Torrey & Hooker
Known specimens: Hardin, Johnson
Other reports: Union
Last historic collection: 1969 Johnson

A new Johnson Co. location for this species was discovered in 1988 just a few miles from the original station (Ketzner 1165, ILLS). No search was conducted at the Union and Hardin county sites, nor at the original Johnson Co. site.

Carex pallescens L.
Known specimens: Fulton, Hancock
Other reports: none
Last historic collection: 1958 Fulton

This species is known from only one collection made during the last 100 years. No precise location information is available for that collection, and no search was made for this species. *Carex pallescens* resembles several more common *Carex* species and may be overlooked in Illinois. Suitable habitat includes dry, open woods, a habitat type that is still available in parts of Illinois.

Carex plantaginea Lamarck
Known specimens: Cook, Jackson
Other reports: none
Last historic collection: 1953 Jackson

This species has not been collected in Cook Co.

since 1896, and its habitat there has almost certainly been destroyed by urban growth. The Jackson Co. collection has vague location information. No populations have been found in recent years, and this species has probably been extirpated from the state.

Carex rostrata Stokes
Known specimens: Cook, Du Page, Henry, McHenry, Randolph, Winnebago (new: Lake)
Erroneous reports: Hancock, Henderson (misidentifications)
Last historic collection: 1978 Du Page
In 1981, the only historic collection sites thought to support populations of this sedge were those in Du Page, Henderson, and Winnebago counties. More recently, it has been found at new locations in Du Page, McHenry, and Winnebago counties, and collected for the first time in Lake Co. (Bowles 1988). Although ten or more populations are now known, this species is still considered to be endangered in Illinois because of continuing impacts to its wetland environment.

Carex striatula Michaux
Known specimens: Hardin, Jackson, Pope, Union
Other reports: none
Erroneous reports: Calhoun (misidentification)
Last historic collection: 1976 Jackson
This species was not found at the three previous collection locations searched in 1988. One Jackson Co. locality is intact, and *Carex striatula* may still occur there, but the other Jackson Co. locality has been destroyed. The northwest Union Co. site is intact, but the reported occurrence there is probably based on an identification error (R. H. Mohlenbrock pers. comm.). Sites in Hardin, Pope, and northeast Union counties were not checked. There is some doubt that the specimens at SIU ascribed to this taxon have been correctly identified, and additional herbarium work is needed to determine if this taxon has ever been collected in Illinois.

Carex tonsa (Fernald) Bicknell
Known specimens: Carroll, Pope (new: Lake)
Other reports: none
Last historic collection: 1966 Pope
In 1988, this species was re-collected in Carroll Co. (Bowles 711, MOR) and collected for the first time in Lake Co. (Bowles 735, MOR). At both locations it occurs in dry sand prairies, a habitat it occupies in the driftless area (Hartley 1966). It was not found at the location in Pope Co. where it was previously collected.

Carex willdenowii Schkuhr
Known specimens: Gallatin (new: Pope, Union)
Other reports:
Last historic collection: 1985 Gallatin
A 1985 Gallatin Co. collection (Parker 1985) is the first record of this species in Illinois. Four additional populations were found during 1988. It was collected from a dry upland forest in Union Co. (Phillippe 13263, ILLS) and was abundant at three sites in Pope Co. (Phillippe 13203, 13211, 13243, ILLS). This sedge strongly resembles *C. jamesii* Schweinitz, and a review of southern Illinois collections of *C. jamesii* may reveal additional collections of *C. willdenowii*.

Carex woodii Dewey
Known specimens: Cook, Kankakee, Will, Winnebago (new: Jo Daviess)
Other reports: Lake
Erroneous reports: St. Clair (misidentification)
Last historic collection: 1980 Cook
This species was recently discovered in Jo Daviess Co. (Schwegman *s.n.*, DOC, 1988). It has also been reported recently from two Lake Co. sites, but no collections were made (Bowles 1987).

Chimaphila maculata (L.) Pursh
Known specimens: Cook
Other reports: Pope
Last historic collection: 1981 Cook
This species was not found in recent searches at the Cook Co. location where it had been collected in 1981, nor at the Pope Co. location where a single individual was sighted in 1974. Undisturbed habitat exists at both sites, and the species could still occur at either of them.

Chimaphila umbellata (L.) Barton
Known specimens: Winnebago
Other reports: Lake, McHenry
Last historic collection: 1945 Winnebago
This species still occurs at the original Winnebago Co. collection site (P. Burton and V. Nuzzo pers. comm.) and was collected from a second Winnebago Co. site in 1987 (Bowles, Burton, and Nuzzo 674, MOR). All Illinois collections of this species are ssp. *cisatlantica* (Blake) Hulten.

Cinna latifolia (Treviranus) Grisebach
Known specimens: Kane, Lake
Other reports: Cook, DeKalb, Winnebago
Last historic collection: 1909 Lake

Location information is vague for the Kane and Lake Co. collection sites, and no populations have been found in recent years. This species is probably extirpated from Illinois.

Conioselinum chinense (L.) Britton, Sterns & Poggenberg
Known specimens: Cook, Kane
Other reports: none
Last historic collection: 1959 Kane

The single population of Hemlock Parsley known to exist in Illinois occurs in a Kane Co. forested fen. Habitat at that site has been affected by highway construction since it was last collected there. Although it was not found during searches conducted in 1988, apparently at least one plant remains at that site (K. Dritz pers. comm.).

Corydalis aurea Willdenow
Known specimens: La Salle, Ogle, Pike
Other reports: Cook, Ford, Hancock, Henderson, Kankakee, Mason, Menard, Union, Winnebago
Erroneous reports: Adams, Champaign, Peoria (misidentifications)
Last historic collection: 1981 Pike

Golden Corydalis is represented in Illinois primarily by pre-1900 records. Verified post-1900 records are from LaSalle, Ogle, and Pike counties. In 1981, a collection was made from an adventive population in Pike Co., but this biennial has not reappeared at that site in subsequent years. It was not found in a 1988 search of intact natural habitat in Ogle Co. However, in 1989, a population of this species was found at a La Salle Co. site where it had previously been known to occur (Jones *s.n.*, MOR).

Corydalis sempervirens (L.) Persoon
Known specimens: Cook, LaSalle, Ogle, Stephenson, Winnebago
Other reports: none
Last historic collection: 1974 Cook

In 1986, this annual was collected from a St. Peter's sandstone cliff in Ogle Co. (McKnight 4959, ILLS) where a small number of individuals occurred in two adjacent populations. No plants were found in 1988, possibly due to drought conditions, but in 1989, fourteen vegetative plants tentatively identified as this species were found at the site. This population is threatened by a locally increasing population of garlic mustard [*Alliaria petiolata* (Bieberstein) Cavara and Grande], an introduced biennial weed.

Cynosciadium digitatum DeCandolle
Known specimens: Jackson
Other reports: none
Last historic collection: 1969 Jackson

This species is known from a single collection for which precise location data are not available. Only a portion of the large area referred to in the collection site description was searched in 1988. Although this species was not found, suitable habitat still remains there.

Cypripedium acaule Aiton
Known specimens: Cook, Lake, McHenry, Ogle
Other reports: none
Erroneous reports: Lee (map error)
Last historic collection: 1972 McHenry

This orchid was not found in the McHenry Co. forested fen where it was collected in 1972 and observed again in 1977 during the Illinois Natural Areas Inventory. This site remains intact, as do sites in Lake and Ogle counties where this species was collected in the 1960's; it is likely that this species still occurs in Illinois.

Daucus pusillus Michaux
Known specimens: Perry (specimen missing: Jackson)
Other reports: none
Last historic collection: (1954 Jackson)

The Jackson and Perry Co. localities were searched in 1987 and in 1988, although the Perry Co. collection site could not be precisely determined. *Daucus pusillus*, an annual, was not present either year. Only one plant was originally noted at the Jackson Co. locality (R.H. Mohlenbrock pers. comm.), and the specimen (Mohlenbrock 3003, SIU, 1954) cannot be located. This species is almost certainly adventive in Illinois.

Eleocharis equisetoides (Elliott) Torrey
Known specimens: Cook
Other reports: none
Erroneous reports: Lake (misidentification)
Last historic collection: 1890 Cook

The only recent record of this species (Lake Co.:

Myers 2533, MWI, 1964) was based on a misidentification. It has not been relocated at the original 1890 collection site in Cook Co., which has been highly modified. The species is probably extirpated from the state.

Eleocharis olivacea Torrey
Known specimens: Cook, Lake
Other reports: Mason
Erroneous reports: Henderson (map error)
Last historic collection: 1976 Lake

In 1988, this species was found (Bowles 839, MOR) at the Lake Co. site where it had been previously collected. At that site, plants are restricted to a few calcareous beach swales.

Eleocharis parvula (Roemer & Schultes) Link
Known specimens: Coles, Effingham
Other reports: none
Last historic collection: 1978 Effingham

This species is known in Illinois from three sites in Coles and Effingham counties. One of the Coles Co. collection sites, the margin of an artificial pond, was searched in 1988, but no plants were found. The other two collection sites, also artificial pond margins, were not searched. This species may be adventive in Illinois.

Equisetum palustre L.
Known specimens: Peoria, Tazewell, Woodford
Other reports: none
Erroneous reports: Kankakee (misidentification)
Last historic collection: 1953 Tazewell

All historic collection sites for this species in Illinois have been disturbed. This horsetail was not found in recent searches of suitable habitat near the original collection sites, and it is probably extirpated from the state.

Equisetum sylvaticum L.
Known specimens: (new: Ogle)
Other reports: none
Last historic collection: new to Illinois

In 1988, this horsetail was discovered new to Illinois from Ogle County (Jones 144, MOR). The plants occur along the bottom and slopes of a small north-facing side ravine developed in St. Peter's sandstone.

Eriophorum viridi-carinatum (Engelmann) Fernald
Known specimens: Lake, Rock Island
Other reports: Henry, Winnebago
Erroneous reports: DuPage (misidentification)
Last historic collection: 1929 Lake

Since 1900, there have been only three reports of this species in Illinois: a 1929 collection from Lake Co., and sightings in Winnebago (Fell 1953) and Henry (Dobbs 1963) counties. Although no recent collections exist for this species, and it was not relocated in 1987 or 1988, it still may occur in the extensive habitat remaining in these counties.

Euphorbia spathulata Lamarck
Known specimens: Monroe
Other reports: none
Last historic collection: 1950 Monroe

A single individual of this western annual species was found recently in Monroe Co. (Taft photograph, ILLS, 1987) at the only Illinois location where this species is known to occur.

Fuirena scirpoides Michaux
Known specimens: (specimen missing: Hamilton)
Other reports: none
Last historic collection: (1970 Hamilton)

In Illinois, this species is known only from an artificial lakeshore in Hamilton Co. where it was collected in 1970. The collector was unable to relocate the population shortly after making the original collection, and the entire population may have been collected (N. Tracy pers. comm.). The species was probably adventive at that site, and was not found during this study. The specimen is missing from the herbarium where it was originally deposited.

Gaultheria procumbens L.
Known specimens: Cook
Other reports: Lake, La Salle, Ogle
Erroneous reports: Peoria
Last historic collection: 1943 Cook

In 1983, this species was collected at a new location in Cook Co. (Evert 6448, MOR). It was not found, however, in searches of other historic collection sites conducted during this study.

Geranium bicknellii Britton
Known specimens: Cook, DuPage, Lake
Other reports: none
Last historic collection: 1974 Cook

Although the Northern cranesbill was observed as recently as 1967 in Lake Co. and 1974 in Cook

Co., it was not found in 1987 and 1988 searches. Since this species tends to appear after fire (Swink and Wilhelm 1979), populations may still occur in seed banks.

Geum rivale L.
Known specimens: Kane
Other reports: McHenry, Winnebago
Last historic collection: 1949 Kane

The most recent collection site for this plant has been highly modified by freeway construction. Numerous searches for this species in remaining suitable habitat have been unsuccessful, and it is probably extirpated from Illinois.

Glyceria arkansana Fernald
Known specimens: Union
Other reports: none
Last historic collection: 1957 Union

In 1988, this species was found in Union Co. (Phillippe 13196-B, ILLS) in the general vicinity of a previous collection site. *G. arkansana* is difficult to distinguish from *G. septentrionalis* Hitchcock in the field. Since they occur together here, it was difficult to estimate population size and extent of *G. arkansana*.

Glyceria borealis (Nash) Batchelder
Known specimens: Cook, Stephenson (specimen missing: Lake)
Other reports: Jo Daviess
Erroneous reports: St. Clair (misidentification)
Last historic collection: 1959 Cook

There have been only three Illinois collections of this species since 1946. Previous collection sites were searched unsuccessfully during 1987 and 1988. However, potential habitat still occurs at sites in Lake and Jo Daviess counties, and this species may remain extant in these areas.

Glyceria canadensis (Michaux) Trinius
Known specimens: Cook
Other reports: Peoria, Tazewell
Last historic collection: 1943 Cook

There is no specific location information for the Illinois collections of this species. It was not found during an extensive survey of suitable habitats in northeastern Illinois during 1988 (Bowles 1988), nor in searches of reported locations in Tazewell Co. It is unlikely that it remains extant in Illinois.

Gnaphalium macounii Greene [K&K: *G. viscosum* HBK.]
Known specimens: none
Other reports: Clark
Last historic collection: 1932 Clark

This biennial species is known in Illinois from a single 1932 report. It has not been relocated in extensive searches of the original collection site, and is presumed to be extirpated from the state.

Habenaria hookeri Torrey [K&K: *Platanthera hookeri* (Torrey ex Gray) Lindley]
Known specimens: Cook, Hancock, Lake
Other reports: none
Last historic collection: 1943 Cook

This species has been collected only once since 1900, at a site that has since been highly modified. It has not been found in suitable habitat elsewhere and is probably extirpated from Illinois.

Hackelia americana (Gray) Fernald [K&K: *H. deflexa* (Wahlenberg) Opiz var. *americana* (Gray) Fernald & I.M. Johnston]
Known specimens: Carroll, Jo Daviess, Winnebago
Other reports: none
Erroneous reports: Lake (misidentification)
Last historic collection: 1965 Carroll

In 1988, this stickseed was collected in Carroll Co. from ledges along the base of west-facing limestone bluffs of the Mississippi River (Bowles and Nyboer 838, MOR). This species occupies similar habitat in other sections of the driftless area (Hartley 1966).

Helianthus giganteus L.
Known specimens: Cook, Kane, Kankakee, Tazewell, Winnebago
Other reports: McLean
Last historic collection: 1951 Winnebago

In 1987, this species was found in graminoid fen habitat in Cook Co. (Nuzzo and Karnes 501, MOR) and was rediscovered in a Winnebago Co. sedge meadow (Bowles 681, MOR).

Heteranthera reniformis Ruiz & Pavon
Known specimens: Lawrence, Wabash, St. Clair (new: Pope)
Other reports: Alexander, Pope, Union
Last historic collection: 1952 Lawrence

This species was noted at a Pope Co. site during the Illinois Natural Areas Inventory. In 1988, it was

found to still occur at that site as a single large colony bordering the pool of a spring in a grazed pasture (Taft 520, ILLS). This species was not found at the Lawrence Co. collection site where suitable habitat remains, nor in a search of the site reported in Union Co. where conditions may no longer be suitable due to rising water levels. The Alexander Co. record may be based on a misidentification, and that collection site that was not examined during this study.

Hymenoxys acaulis (Pursh) Parker var. ***glabra*** (Gray) Parker
Known specimens: Will
Other reports: Kankakee, Tazewell
Last historic collection: 1947 Will

The last known Illinois population of this species was destroyed in Will Co. in 1981. Searches of remaining suitable habitat and reported collection sites have been unsuccessful. A recovery plan has been initiated involving native material from cultivation and material from an out-of-state source.

Hypericum boreale (Britton) Bicknell
Known specimens: none
Other reports: Cook, Iroquois
Erroneous reports: Pope (misidentification)
Last historic collection: none

The only Illinois specimen ascribed to this species was a misidentified collection of *H. mutilum*. The only other specific record for this species is from a field study of a Cook Co. site (Armstrong 1963), but no specimens to substantiate this report have been found. Since the similar *H. mutilum* occurs at that site and was not recorded in the 1963 study, it is probable that this report was also based on a misidentification.

Hypericum densiflorum Pursh
Known specimens: Massac
Other reports: Alexander
Erroneous reports: Jackson (misidentification)
Last historic collection: 1950 Massac

Searches for this species in Alexander, Jackson, and Massac counties were unsuccessful. The Jackson Co. report is apparently based on a misidentification of *H. denticulatum* Walter (R.H. Mohlenbrock pers. comm.). Only one Illinois specimen of this species still exists (Bailey and Swayne *s.n.*, SIU, 1950, Massac Co.). Since *Hypericum densiflorum* and *H. lobocarpum* Gattinger (formerly *H. densiflorum* Pursh var. *lobocarpum* (Gattinger) Svenson) are difficult to distinguish when fruits are not present, identity of this non-fruiting specimen has not been confirmed. Further herbarium work is needed to verify the presence of *H. densiflorum* in Illinois.

Juncus vaseyi Engelmann
Known specimens: Cook, Winnebago
Other reports: McHenry
Last historic collection: 1947 Winnebago

In 1987 this species was rediscovered (Bowles 690, MOR) at the sedge meadow site in Winnebago Co. where it had last been collected in Illinois.

Justicia ovata (Walter) Lindau
Known specimens: Alexander, Pulaski
Other reports: Massac
Last historic collection: 1951 Pulaski

Extensive areas of suitable habitat in Pulaski Co. have been explored, but this species was only found at a single station (Ketzner 1198, ILLS, 1988). No precise location information is available for the Alexander Co. collection site.

Lactuca ludoviciana (Nuttall) Riddell
Known specimens: Macon, McHenry, Stark
Other reports: Calhoun, Carroll, Clay, Cook, De Kalb, Hancock, Kankakee, Lake, Logan, Macoupin, Monroe, Stephenson
Erroneous reports: Boone, Winnebago (misidentification)
Last historic collection: 1939 Macon

This species has been reported from seventeen counties in Illinois, but several reports and collections are based on misidentifications. Efforts to relocate this species in 1987 and 1988 were unsuccessful. It was not found on limestone ledges in Monroe Co., where it was reported (Ozment 1967), nor was it found at reported locations in Clay and Stark counties. The relatively high number of former records and the widespread existence of potential habitat suggest that the plant may remain extant in Illinois.

Lathyrus maritimus (L.) Bigelow [K&K: *L. japonicus* Willdenow]
Known specimens: Cook, Henry, Lake
Other reports: none
Last historic collection: 1968 Lake

Modern collections of the beach pea are known

primarily from beach habitat in Lake Co., where it was last observed in 1977 during the Illinois Natural Areas Inventory. The species has not been found during extensive recent surveys, and erosion from high lake levels has severely affected its habitat. It is conceivable that it persists, or that it will reappear by seed dispersal from adjacent Wisconsin populations.

Lipocarpha maculata (Michaux) Torrey
Known specimens: Cass
Other reports: none
Last historic collection: 1963 Cass

Nine collections of this sedge were made by R.T. Rexroat between 1957 and 1963, all from the margins of sand ponds in Cass Co. This species has not been reported in Illinois since. Although several sites were searched without success in 1987 and 1988, suitable habitat remains and this species, an annual, may again appear in the state.

Lycopodium inundatum L.
Known specimens: Cook, Ogle (new: Lee)
Other reports: none
Last historic collection: 1965 Ogle

This club moss was not found at the only recent collection locality. However, in 1987 it was collected in the swale of a Lee Co. sand prairie (Burton and Rogers 835, ILLS).

Medeola virginiana L.
Known specimens: Cook, LaSalle
Other reports: Hancock
Last historic collection: 1939 Cook

Indian cucumber-root was observed in mesic sand forest in Cook Co. during the Illinois Natural Areas Inventory. It remains extant at that site (Bowles pers. obs.).

Melampyrum lineare Desrousseaux
Known specimens: Cook
Other reports: none
Last historic collection: 1952 Cook

Cow wheat is known from three Cook Co. collections. It was observed at the site of the last of these collections during the Illinois Natural Areas Inventory, but it was not found in a search of that site in 1988. Suitable habitat remains intact at that locality, and the plant may still occur there.

Panicum boreale Nash [K&K: *Dichanthelium boreale* (Nash) Freckmann]
Known specimens: Lake (new: Cook)
Other reports: Cook, St. Clair
Last historic collection: 1944 Lake

In 1988, this species was collected (Bowles, Nuzzo, and Dritz 854, MOR) at a Cook Co. site where it had been previously reported (Armstrong 1963). It occurs at that site in a sand pit under successional woody vegetation. No search was made of sand savanna habitat at the Lake Co. site where this grass was originally collected and may still occur.

Panicum columbianum Scribner [K&K: *Dichanthelium sabulorum* (Lamarck) Gould & Clark var. *thinium* (A.S. Hitchcock & Chase) Gould & Clark; RHM: *D. columbianum* (Scribner) Freckmann]
Known specimens: La Salle, Ogle (specimen missing: Kankakee)
Other reports: Du Page
Last historic collection: 1945 Kankakee

In 1987 this species was found (Bowles 672, MOR) on dry sandstone ledges in La Salle Co. where collections had been made in the early 1900's.

Panicum hians Elliott
Known specimens: none
Other reports: none
Erroneous reports: Alexander (misidentification)
Last historic collection: none

The single herbarium specimen representing this species in Illinois (Alexander Co.: Mohlenbrock 13004, SIU, 1968) was annotated as *P. verrucosum* Muhlenberg during this study. *P. hians* apparently does not occur in Illinois.

Panicum longifolium Torrey
Known specimens: (specimen missing: Monroe)
Other reports: none
Erroneous reports: Edgar (misidentification)
Last historic collection: (1962 Monroe)

This grass is known in Illinois only from a wooded ravine in Monroe Co., where it was collected in 1962 (Ozment 12794, SIU). In 1988, ravines and adjoining hill prairie in the vicinity of the original collection site were searched without success. It is possible that the grass was present only in a vegetative state due to drought and may have gone unnoticed. Since this specimen is missing from the SIU herbarium, the species identification cannot be verified.

Panicum nitidum Lamarck [K&K: *Dichanthelium acuminatum* (Swartz) Gould & Clark; RHM: *D. nitidum* (Lamarck) Mohlenbrock]
Known specimens: (specimen missing: Jackson)
Other reports: Pope, Wabash
Last historic collection: (1967 Wabash)

This species was not found at reported collection locations in Wabash and Jackson Co. A reported Pope Co. location for this species appears to be based on a misidentification. Since no voucher specimen exists for the Wabash Co. location and the voucher specimen for Jackson Co. is missing from the SIU herbarium, it can not be verified that this species ever occurred in Illinois.

Panicum ravenelii Scribner and Merrill [K&K: *Dichanthelium ravenelii* (Scribner and Merrill) Gould]
Known specimens: Hardin, Union
Other reports: Pope
Last historic collection: 1968 Hardin, Union

This species was found during 1988 in Hardin Co. (Phillippe 13333, ILLS). Only three plants were present adjacent to small rock outcroppings in an open area beneath a powerline. No plants were found at the Union Co. location reported for this species, but suitable habitat remains there.

Panicum stipitatum Nash
Known specimens: Johnson
Other reports: none
Erroneous reports: Pulaski (misidentification)
Last historic collection: 1964 Johnson

This species is known in Illinois only from a single Johnson Co. collection (Mohlenbrock 12634, SIU, 1964). The specimen is immature and cannot be positively ascribed to *P. stipitatum*. A single plant matching this collection was observed during a 1987 search of the original collection site, but no specimen was collected.

Paspalum bushii Nash [K&K: *P. setaceum* Michaux var. *stramineum* (Nash) D. Banks]
Known specimens: Jackson, Mason, Schuyler (new: Lee, Madison)
Other reports: Cass, Union
Last historic collection: 1963 Jackson

There have been four recent collections of this species in Illinois: from Lee (Burton and Rogers 829, ILLS, 1987), Madison (Taft 468, ILLS, 1987), and Mason (Phillippe 13425, ILLS, 1988; Moran 1360, ILLS, 1981) counties. Reported localities in Jackson and Union counties were not searched, but the habitat is intact. This species intergrades with the more common *Paspalum ciliatifolium* Michaux and is considered by some authors to be a variety of that species (Gleason 1952). A survey of the *P. ciliatifolium* complex in Illinois herbaria may reveal that *P. bushii* is more common than formerly believed.

Paspalum dissectum L.
Known specimens: Perry, Pulaski, St. Clair (new: Williamson)
Other reports: Johnson
Erroneous reports: Edwards, Jackson, Lawrence (misidentifications)
Last historic collection: 1893 Perry

The species was found in Williamson Co. in 1985 (Ulaszek 1204, ILLS), and recollected there in 1987 (Ulaszek 1325, ILLS). The population at that site, an artificial pond, appears to be adventive, but it may have originated from native populations in nearby bottomland swamps.

Paspalum lentiferum Lamarck [K&K: *P. praecox* Walter]
Known specimens: Pulaski
Other reports: none
Erroneous reports: Massac (misidentification)
Last historic collection: 1961 Pulaski

This species is known in Illinois from a single Pulaski Co. roadside location. This site has been highly modified, and searches there were unsuccessful. The species appears to have been adventive there and probably no longer occurs in Illinois. The Massac Co. report is based on a misidentification of *Paspalum laeve* Michaux var. *circulare* (Nash) Fernald.

Phacelia gilioides Brand
Known specimens: Calhoun
Other reports: St. Clair
Erroneous reports: Jersey (map error)
Last historic collection: 1968 Calhoun

The Calhoun Co. location was searched extensively in 1987 and 1988, but this plant was not found. Drought may have prevented its development during both years. Under more favorable conditions, *Phacelia gilioides* may reappear at this intact hill prairie site. The St. Clair Co. location was not searched.

Phlox carolina L. ssp. ***angusta*** Wherry
Known specimens: Macoupin
Other reports: Jefferson
Last historic collection: 1956 Macoupin

A reported Jefferson Co. location for this species (Wherry 1955) was searched in 1988, but no *Phlox* species were found. The habitat in that area is disturbed and probably now unsuitable. The Macoupin Co. location is not precisely described. However, the general area was extensively searched and no *Phlox* species were found. The single known Illinois specimen of this taxon (Macoupin Co.: Winterringer 13446, ISM, 1956), annotated by D.A. Levin, is very similar to *P. glaberrima* L. ssp. *interior* (Wherry) Wherry and field recognition would be difficult. It is possible that a review of *P. glaberrima* herbarium specimens not examined by Levin would reveal additional collections of *P. carolina* from Illinois. In his key to the genus, Mohlenbrock (1986) distinguishes *P. carolina* on the basis of characters which fit *P. carolina* ssp. *carolina*, but not *P. carolina* ssp. *angusta*.

Phlox pilosa L. ssp. ***sangamonensis*** Levin & Smith
Known specimens: Champaign, Piatt
Other reports: none
Last historic collection: 1953 Champaign

In 1987, this species was rediscovered in a degraded prairie remnant in Champaign Co. (Solecki *s.n.*, ILLS).

Physostegia intermedia (Nuttall) Engelmann & Gray
Known specimens: none
Other reports: Adams
Erroneous reports: Henderson (misidentification)
Last historic collection: none

No valid Illinois specimens of this species are known to exist. The pre-1900 Henderson Co. specimen originally ascribed to this species appears to have been mislabeled (Cantino 1982). Mohlenbrock (1963) reports this species for an Adams Co. station, but does not cite a specimen.

Plantago heterophylla Nuttall
Known specimens: Pulaski, Union
Other reports: none
Last historic collection: 1958 Pulaski

Precise location information is lacking for the only two Illinois collections of this species. Searches conducted of the general vicinity at both locations were without success. Populations at both sites, one described as occurring in a field of corn stubble, may have been adventive. It is likely that this species no longer occurs in Illinois.

Poa wolfii Scribner
Known specimens: Fulton, Henderson, Peoria (new: Adams, Brown)
Other reports: Cook
Last historic collection: 1888 'Illinois'

This species has recently been discovered in Brown (Schwegman 3179, ISM, 1984; Shildneck 15262, ISM, 1986) and Adams (Taft 458, ILLS, 1987) counties, having been known previously only from pre-1900 collections in Fulton, Henderson, and Peoria counties.

Polygonum bicorne Rafinesque
Known specimens: Alexander, Kendall, Randolph, St. Clair, Union (new: Gallatin, Jackson, Madison, Monroe, Wayne)
Other reports: none
Erroneous reports: Macon (map error)
Last historic collection: 1974 Kendall

During 1988, populations were found at four sites in Alexander Co. (Phillippe 13523, 13524, 13525, 13527, ILLS), and at two sites in Union Co. (Phillippe 13528, 13529, 13535-A, 13535-B, ILLS). It was also found for the first time at two sites in Gallatin Co. (Phillippe 13536-A, 13536-B, ILLS), and at one site in Wayne Co. (Ulaszek 1359, ILLS). During 1989, populations were found in Monroe Co. (Brooks and Phillippe 13796, ILLS), St. Clair Co. (Morris, Perino, Ulaszek, and Phillippe 13811, ILLS; Phillippe and Ulaszek 1390, ILLS), at two sites in Madison Co. (Morris, Ulaszek, and Phillippe 13812, 13813, ILLS), and at two sites in Jackson Co. (Morris 76, 81, ILLS). Collection locations in Kendall and Randolph counties were not searched. All of the populations of this annual were found in open wetlands. Several plants were in depressions along the edges of cultivated fields. It appears that *P. bicorne* is actually not rare, but rather that it is frequently overlooked due to its general similarity to the more common *P. pensylvanicum* L. *P. bicorne* has been treated as synonymous with *P. pensylvanicum* by Kartesz and Kartesz (1980). However, Gleason's (1952) treatment of these taxa as distinct species appears to be the correct one, although Gleason refers to this taxon as *P. longistylum* Small.

Potamogeton gramineus L.
Known specimens: Cook, Lake (new: McHenry)
Other reports: Kankakee, Lawrence, McHenry, Wabash
Last historic collection: 1975 Cook

In 1987, this pondweed was found at a new location in Lake Co. (Schlomer *s.n.*, MOR) and collected for the first time in McHenry Co. (Wilhelm and Bowles 15517, MOR).

Potamogeton praelongus Wulfen
Known specimens: Cook, Lake, McHenry
Other reports: none
Last historic collection: 1932 Lake

Only five historic collections of this aquatic species are known, and these are restricted to glacial lakes in three northeastern Illinois counties. One former collection site was searched in 1987 and 1988, but the plant was not found. However, it is possible that this species persists in this and other northeastern Illinois glacial lakes.

Potamogeton pulcher Tuckerman
Known specimens: Jackson, Kane
Other reports: Mason, Menard, St. Clair
Last historic collection: 1980 Kane

This species was collected fairly recently in Kane Co. (Young *s.n.*, 1980, MOR) and probably still occurs there. Part of the Jackson Co. collection site was searched in 1988, but this species was not found.

Potamogeton robbinsii Oakes
Known specimens: Cook, Lake (new: McHenry)
Other reports: none
Last historic collection: 1975 Cook

In 1987 this aquatic species was rediscovered at the 1975 collection site in Cook Co. (Bowles and Apfelbaum 692, MOR, 1987) and collected for the first time in McHenry Co. (Wilhelm and Bowles 15518, MOR).

Potamogeton strictifolius A. Bennett
Known specimens: Cook, Lake
Other reports: none
Last historic collection: 1966 Lake

Although this species could not be re-located during 1987 or 1988, the two collection sites remain intact and could still support populations.

Potamogeton vaseyi J.W. Robbins
Known specimens: McHenry
Other reports: none
Erroneous reports: Grundy, Henry, Will (misidentifications)
Last historic collection: no date McHenry

The only valid Illinois specimen of this species is the original pre- 1900 McHenry Co. collection by Vasey. Other collections, including several fairly recent ones, were misidentified. The precise location of the original collection site is unknown and could not be searched.

Potentilla millegrana Engelmann [K&K: *P. rivalis* Nuttall]
Known specimens: St. Clair, Union
Other reports: Johnson
Last historic collection: 1971 Union

The Union Co. site where this species was last collected has been flooded and no longer provides suitable habitat. The St. Clair Co. collections were all made prior to 1900, some from disturbed urban sites. These sites were not searched, but suitable habitat may remain in the vicinity and this species may still be present.

Ptilimnium nuttallii (DeCandolle) Britton
Known specimens: Jackson, Randolph, Union
Other reports: Pulaski, St. Clair
Last historic collection: 1954 Randolph

In 1987 this species was collected (Ketzner 1085, ILLS) at the Randolph Co. location where it had been reported in 1954.

Puccinellia pallida (Torrey) Clausen [K&K: *Torreyochloa pallida* (Torrey) Church]
Known specimens: Union
Other reports: none
Last historic collection: 1969 Union

This species is known in Illinois only from one vicinity in Union Co. This area was searched in 1988, and plants were found at two locations (Phillippe 13197, 13267, ILLS). This species is locally common, growing in shallow water between *Decodon* thickets and adjacent forested areas.

Pycnanthemum albescens Torrey & Gray
Known specimens: Union
Other reports: none
Erroneous reports: Jackson (misidentification)
Last historic collection: 1973 Union

In Illinois, white mountain mint is known from a single collection. An extensive search was made of the collection site and the surrounding area. Although *Pycnanthemum albescens* was not found, other as yet unsearched habitat for this species exists nearby. Recent prescribed burning at and in the vicinity of that site may result in the reappearance of this species.

Pyrola americana Sweet
Known specimens: Ogle
Other reports: none
Last historic collection: 1946 Ogle

In 1946, this species was collected twice from a St. Peter's sandstone ravine in Ogle Co., but precise location information is lacking. Attempts to find it in 1987 and 1988 were unsuccessful. Since the vegetatively similar *P. elliptica* Nuttall is common in this area, non-flowering individuals of *P. americana* may have been overlooked. However, all of the flowering *Pyrola* observed during 1988 was *P. elliptica*.

Pyrola secunda L. [K&K: *Orthilia secunda* (L.) House]
Known specimens: no locality given
Other reports: none
Erroneous reports: Winnebago (misidentification)
Last historic collection: no date (pre-1900) Cook?

The inclusion of this species in the Illinois flora is based on three specimens. Two Winnebago Co. collections are vegetative and cannot be conclusively identified. It is likely, however, that they are misidentifications of *Pyrola elliptica* Nuttall, which is present at the site where these collections were made. The third specimen is a pre-1900 collection without date or locality information. The identity of this specimen cannot be confirmed because the inflorescence has been lost. *Pyrola secunda* may never have occurred in Illinois.

Ranunculus ambigens S. Watson
Known specimens: Fulton, Hancock, St. Clair, Wabash
Other reports: none
Erroneous reports: Jackson (misidentification)
Last historic collection: 1891 Wabash

This species was not found during the 1987 search of the Jackson Co. collection site, but the similar *Ranunculus laxicaulis* (Torrey and Gray) Darby was present. Subsequent re-examination of the original specimen from this site revealed that it had been misidentified (T. Duncan pers. comm.). All other Illinois collections were made prior to 1900. It appears unlikely that this species still occurs in Illinois.

Ranunculus cymbalaria Pursh
Known specimens: Cook, Du Page, Kane (new: Lake)
Other reports: McHenry
Last historic collection: 1940 Cook

In 1986 this wetland species was collected in Lake Co. (Dritz 457, MOR) where it had not previously been known to occur. The population, located along an interstate highway, appears to be adventive, but it may have originated from a natural population.

Rhamnus alnifolia L'Heritier
Known specimens: Adams, Boone, Kane, Kendall, Lake, McHenry, Peoria, Tazewell
Other reports: Richland
Last historic collection: 1971 Peoria

In 1988, this buckthorn was collected in Kendall Co. (Bowles, Wilhelm, and Dritz 812, MOR) from a spring-run margin of a graminoid fen.

Rhynchospora globularis (Chapman) Small
Known specimens: Cook
Other reports: Kankakee
Last historic collection: 1940 Cook

This species is known only from reports of pre-1900 collections in Kankakee Co. and a single 1940 Cook Co. collection. Precise locational information is not available, but habitat in the vicinity of the original collection sites was searched during 1987 and 1988. No plants were found, but since suitable habitat remains at these sites and populations are known to occur at nearby locations in Indiana, this species may still occur in Illinois.

Rhynchospora macrostachya Torrey
Known specimens: none
Other reports: Cook
Erroneous reports: Pulaski (misidentification)
Last historic collection: none

There are no specimens substantiating the occurrence of this sedge in Illinois. The single specimen originally ascribed to this species (Mohlenbrock 5542, SIU) is immature and cannot be positively identified, but resembles *R. corniculata*

(Lamarck) Gray more than *R. macrostachya*. The Pulaski Co. site where this specimen was collected was searched in 1987 and only *R. corniculata* was found. The Cook Co. station is based on a 1947 sight record (F. Swink pers. comm.)

Rorippa truncata (Jepson) R. Stuckey
Known specimens: St. Clair (specimen missing: Jackson)
Other reports: Alexander, Madison
Erroneous reports: Cass (misidentification)
Last historic collection: 1976 Jackson

This species was not found in a search of locations in St. Clair, Madison, and Alexander counties where it has been reported to occur in bottomlands of the Mississippi River. The Jackson Co. lakeshore site was also searched unsuccessfully. It appears that the latter record may be based on a misidentification, but the herbarium specimen could not be located at SIU. A St. Clair Co. specimen deposited at NY was examined by R.L. Stuckey and cited as *R. truncata* in his monograph on *Rorippa* (Stuckey 1972). His description of the distribution of this species suggests that if it occurs in Illinois today, it would be in the bottomlands of the Mississippi River near or below its confluence with the Missouri.

Rumex hastatulus Baldwin
Known specimens: Madison, St. Clair
Other reports: none
Erroneous reports: Grundy (misidentification)
Last historic collection: 1960 St. Clair

The historical collection locations for this species are not precisely described. There is extensive suitable habitat in the general vicinity of the Madison Co. sites, but searches there were unsuccessful. Searches in 1987 and in 1988 of the St. Clair Co. area where this species was last collected were also unsuccessful. Access was denied to nearby areas of suitable habitat along the Mississippi River where this species may persist.

Salix serissima (Bailey) Fernald
Known specimens: Cook, Lake, McHenry
Other reports: none
Last historic collection: 1959 Lake

Although this willow was not found in recent searches of the forested bogs where it was previously collected, extensive habitat remains at two sites, and it is likely that it persists.

Salix syrticola Fernald [K&K: *S. cordata* Michaux]
Known specimens: Cook, Lake
Other reports: none
Last historic collection: 1968 Lake

Although dune willow was formerly characteristic of the lakeshore dunes of Cook and Lake counties (Swink and Wilhelm 1979), its habitat is being reduced by lakeshore erosion. The species appears now to be very rare in Illinois. It was recently collected at a lakeshore dune in Lake Co. (Bowles and Dritz 781, MOR, 1988).

Scheuchzeria palustris L.
Known specimens: Lake, McHenry
Other reports: Fulton, Menard
Last historic collection: 1952 Lake

This species is known only from a single modern record, a 1952 collection from Lake Co. The plant was not found during an extensive survey of the collection vicinity (Sheviak and Haney 1973) and it has not been observed during more recent surveys. All Illinois specimens of this species are var. *americana* Fernald.

Schizachne purpurascens (Torrey) Swallen
Known specimens: Jo Daviess
Other reports: none
Last historic collection: 1937 Jo Daviess

This grass is known in Illinois from a single location in Jo Daviess Co. where it occurs on wooded limestone bluffs and ravine slopes. It was found again at that site in 1987 (Heim *s.n.*, MOR).

Scirpus hattorianus Makino
Known specimens: Cook, Kankakee
Other reports: Carroll
Last historic collection: 1973 Kankakee

Suitable habitat apparently remains in the Kankakee Co. area where this species was last collected; although it has not been relocated, it may still occur there. No search was made of the Cook Co. location, where it was collected in 1906.

Scirpus microcarpus Presl
Known specimens: Lake
Other reports: none
Last historic collection: 1909 Lake

This species was collected several times prior to 1910 in one locality of Lake Co., but has not been reported since in spite of extensive botanical

collecting in the area. Although much of its original habitat remains undisturbed, it appears likely that this species has been extirpated from Illinois.

Scirpus pedicellatus Fernald
Known specimens: Cook
Other reports: Pope
Last historic collection: no date Cook

One of the two Cook Co. sites where this rush is known to have occurred has been destroyed, and the other has undergone ecological changes since the time of collection. Search of the latter site was unsuccessful, and it appears unlikely that this species persists there. No search was made at the reported Pope Co. location. Some authors question the taxonomic validity of this species (*e.g.*, Swink and Wilhelm 1979).

Scirpus purshianus Fernald
Known specimens: Lawrence, Mason, Menard, Pope
Other reports: Hancock
Erroneous reports: Cass (misidentification)
Last historic collection: 1967 Mason

This sedge was not found in a 1988 search of the Lawrence Co. location where it was collected in 1952, but this species may still occur there. *Scirpus purshianus* is also represented by Mason Co. collections made during 1967 and misidentified as *S. smithii* Gray. One of the Mason Co. sites has been destroyed, and other sites which may have provided suitable habitat when this species was last collected have since undergone successional changes.

Scirpus smithii Gray
Known specimens: Cass, Mason, Peoria
Other reports: Coles, Richland
Erroneous reports: Marion, Menard (misidentifications)
Last historic collection: 1969 Cass

The only modern Illinois collections of this species now considered valid are from Cass Co., since several collections made since 1900 have subsequently been annotated as *S. purshianus* Fernald. The 1861 collection from Mason Co. lacks specific location information. In 1989 a limited and unsuccessful search was made of the Cass Co. collection vicinity.

Scirpus torreyi Olney
Known specimens: Lee, St. Clair
Other reports: Winnebago
Erroneous reports: Marshall (misidentification)
Last historic collection: 1959 Lee

Although this species was not found during 1987 or 1988 searches, apparently suitable habitat remains in Lee and Winnebago counties and it may persist there. It occurs in northwestern Indiana, and may also be present in extensive habitat remaining in adjacent Iroquois Co., Illinois.

Scirpus verecundus Fernald
Known specimens: Alexander
Other reports: Union
Last historic collection: 1974 Alexander

The Alexander Co. locality where this species was found previously (Mohlenbrock *s.n.*, SIU) is intact and was searched in 1988 and 1989, but *Scirpus verecundus* was not found. Discrepancies between habitat characteristics at this site and at locations where this species is known to occur in Missouri and Arkansas suggest that the recorded collection location may be inaccurate. R.H. Mohlenbrock (pers. comm.) reports observing, but not collecting, *S. verecundus* in a Union Co. ravine in 1974. That site was searched in 1989 but without success.

Scleria reticularis Michaux
Known specimens: Cass, Lee
Other reports: none
Last historic collection: 1969 Cass, Lee

The netted nut-rush was reported in Illinois based on several collections made in Cass and Lee counties between 1956 and 1969. Although it was not found during searches in the vicinity of the Cass Co. collection sites in either 1987 or 1988, extensive suitable habitat occurs in this area, and it may have been overlooked. This species occurs in northwestern Indiana and could occur in similar habitat in adjacent Illinois. There is some doubt about the taxonomic status of *Scleria reticularis*. Godfrey and Wooten (1979) placed *S. muhlenbergii* Steudel into synonymy with *S. reticularis*, while Core treated them as separate species in his 1936 monograph. An examination of herbarium specimens labeled as *S. reticularis* at MOR, ISM, and ILLS showed that under Core's treatment, most would be ascribed to *S. muhlenbergii*, a species which has not been reported previously from Illinois. One specimen (Cass: Rexroat 3438, ISM, 1956) was annotated as *S. reticularis* by Core, but subsequent examination suggests that it too should be ascribed

to *S. muhlenbergii* (A. Koelling pers. comm.).

Shepherdia canadensis (L.) Nuttall
Known specimens: Cook, Lake
Other reports: none
Last historic collection: 1976 Lake

This species has not been reported since its 1976 collection. Although it may still occur at several of the Cook and Lake Co. sites where it was previously collected, it is severely endangered by shoreline erosion and succession in its lake-bluff habitat.[1]

Sisyrinchium montanum Greene
Known specimens: Cook, Du Page, Lake
Other reports: Kankakee, Winnebago
Last historic collection: 1974 Lake

This species was collected in 1983 and 1986 at a single Cook Co. location (Balaban *s.n.*, MOR, 1983; Packard and Balaban *s.n.*, MOR, 1986), and has since been reported from at least two other Cook Co. locations. No search was made at other previous collection locations.

Solidago arguta Aiton
Known specimens: Union
Other reports: Jackson
Erroneous reports: LaSalle (misidentification)
Last historic collection: 1958 Union

This species was not found in a search of the Union Co. location where it was previously collected. All collections from this site have subsequently been annotated *S. strigosa* Small or *S. boottii* Hooker, taxa which are included within the concept of *S. arguta* accepted by the Illinois Endangered Species Protection Board (1989). The single known La Salle Co. specimen appears to have been misidentified. *S. arguta* has been reported from a dry woods community in Jackson Co. (Heineke 1978), but that site was not searched during this study.

Solidago remota (Greene) Friesner
Known specimens: none
Other reports: Cook, Lake
Erroneous reports: Kankakee, Pike (misidentifications)
Last historic collection: none

It appears that there are no valid Illinois specimens of this species, and there is, in addition, some doubt about its taxonomic validity. Reports from Illinois are based on citations in Jones and Fuller (1955), on misidentified specimens, or on unvouchered reports by the Illinois Natural Areas Inventory. Swink and Wilhelm (1979) and Sieren (1981) consider local reports of this taxon to be based on misidentifications of *Solidago gymnospermoides* (Greene) Fernald (= *Euthamia gymnospermoides* Greene), a species which is fairly widespread in Illinois.

Sorbus americana Marshall
Known specimens: Cook, Ogle
Other reports: none
Erroneous reports: Lake (misidentification)
Last historic collection: 1972 Ogle

Mountain ash is currently known from a single Ogle Co. site, and was found to still occur there in 1988 (Bowles and Nyboer 737, MOR). This population consists of several trees growing on a north-facing St. Peter's sandstone ledge.

Sparganium americanum Nuttall
Known specimens: Fulton, Kane, Lee, Pike, Stephenson (new: Winnebago)
Other reports: Cook, Du Page, Knox, McHenry, Union, Winnebago
Last historic collection: 1980 Stephenson

This aquatic species was found in Winnebago Co. in 1987 (Bowles 680, MOR). Habitat at the 1980 Stephenson Co. collection site has been destroyed, but another 1980 collection site in Kane Co. remains intact. No search was made of other previous collection locations, most of which cannot be precisely identified.

Sphaeralcea angusta (Gray) Fernald [K&K: *Sidopsis hispida* (Pursh) Rydberg]
Known specimens: Grundy, La Salle, Rock Island, St. Clair, Will
Other reports: none

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[1]Editor's Note: After submission of this manuscript, John Schwegman reported the discovery of 3 populations of *Shepherdia canadensis* from Lake Co., IL during a shoreline study by boat. Specimens are currently retained at the Illinois Dept. of Conservation, Springfield, IL.

Last historic collection: 1974 Will

The globe mallow is possibly adventive at several of the Illinois locations where it has been collected. However, a 1972 Grundy Co. collection is from a disturbed natural habitat that may represent a native population. Several reported Grundy Co. sites were searched in 1988 without finding this species, but drought conditions may have caused dormancy or prevented development of flowering plants. Another reported site in Grundy Co. has been destroyed by construction activity.

Spiranthes lucida (H.H. Eaton) Ames
Known specimens: Cook, Lake, Woodford
Other reports: Hancock, Will
Last historic collection: 1973 Cook

This orchid was not found at the restored prairie in Cook Co. where it was most recently collected nor was it found at the Woodford Co. collection site, which has been significantly altered by flooding of the Illinois River. However, this species is known to occur in successional habitats and may still occur in northern Illinois.

Spiranthes romanzoffiana Chamisso
Known specimens: Coles, Cook, McHenry
Other reports: Peoria
Last historic collection: 1977 McHenry

Since 1947, this species has been collected only from a single McHenry Co. sphagnum bog. It was not found in a 1988 search of that site, but the habitat remains intact and it may persist there.

Stachys clingmanii Small
Known specimens: none
Other reports: none
Erroneous reports: Alexander, Hardin, Henry, Massac, Pulaski, St. Clair (misidentifications)
Last historic collection: none

All Illinois specimens ascribed to this species were misidentified, with most subsequently annotated as *S. tenuifolia* Willdenow or *S. aspera* Michaux. Nelson (1981) considers this to be a species of the Blue Ridge Mountains.

Thismia americana N.E. Pfeiffer
Known specimens: Cook
Other reports: none
Last historic collection: 1912 Cook

Until recently, this saprophyte had been reported from only one site, a moist sand prairie which has since been destroyed. However, correspondence from the collector indicates that the species also occurred at locations some distance from the original site (Mohlenbrock 1985). Numerous attempts to find it in similar habitats have been unsuccessful, but since this species is small and inconspicuous, the possibility remains that it has been overlooked in these searches.

Tradescantia bracteata Small
Known specimens: Adams, Greene, Hancock, Henry, Jersey, Mason, Menard, St. Clair (new: Madison, McDonough)
Other reports: Madison, Morgan, Peoria, Winnebago
Last historic collection: 1969 Hancock

This spiderwort has been collected several times in recent years. It was recorded in McDonough Co. for the first time in 1984 (Henry 4276, MWI), and was subsequently collected in Madison (Solecki *s.n.*, ILLS, 1985), Greene (Solecki *s.n.*, ILLS, 1987), and Menard (Solecki *s.n.*, ILLS, 1987) counties.

Triadenum virginicum (L.) Rafinesque
Known specimens: Lake
Other reports: Will
Last historic collection: 1972 Lake

This species is known in Illinois from a single Lake Co. collection. Repeated searches for it at the collection site, a peaty sand prairie near Lake Michigan, have failed. However, since the very similar *T. fraseri* (Spach) Gleason is common at this site, *T. virginicum* may have been overlooked. *T. virginicum* still occurs in similar habitats in northwestern Indiana.

Trillium cernuum L.
Known specimens: Cook, McHenry
Other reports: none
Last historic collection: 1929 Cook

The only post-1900 Illinois report of nodding trillium is a historic site observation in Cook Co. (R. Kral pers. comm.). This area is one of the few remaining potential habitats for this species in Illinois, but it was not found there in a 1988 search. However, this trillium still occurs in northeastern Indiana, and it may remain extant in Illinois. All Illinois collections of this species are var. *macranthum* Eames & Wiegand.

Trillium cuneatum Rafinesque

Known specimens: Union
Other reports: none
Erroneous reports: Jackson (map error)
Last historic collection: 1960 Union

This trillium is known in Illinois from a single Union Co. collection. It was observed but not collected at that site in 1987 (J. Schwegman pers. comm.).

Vaccinium stamineum L.
Known specimens: Pope
Other reports: none
Last historic collection: 1962 Pope

In a search of the original collection locality for this species, only the somewhat similar *V. arboreum* Marshall was found. A report of *V. stamineum* from another Pope Co. location (J. Graber pers. comm.) needs further investigation, since a partial search of that site in 1987 also revealed only *V. arboreum*. Reports of *V. stamineum* based on vegetative material should be regarded as questionable until flowering material is available.

Valerianella intermedia Dyal
Known specimens: Kankakee
Other reports: La Salle, Will
Erroneous reports: Fayette, Monroe, Union (misidentifications of *V. radiata* (L.) Dufresne)
Last historic collection: 1966 Kankakee

Valerianella intermedia is no longer recognized as a valid species. It is now considered a morphological form of *V. umbilicata* (Sullivant) Wood and has been placed in synonymy with that species (Eggers Ware 1983). Specimens from Kankakee Co. formerly referred to this taxon are now considered to be *V. umbilicata*.

Valerianella umbilicata (Sullivant) Wood
Known specimens: Kankakee, La Salle, Will
Other reports: none
Erroneous reports: (see *V. intermedia*)
Last historic collection: 1949 La Salle (1966 Kankakee as *V. intermedia*)

This species was rediscovered in Kankakee Co. in 1985 (Schwegman *s.n.*, DOC). No search was made of this or other previous collection locations during this study.

Veronica americana (Rafinesque) Schweinitz
Known specimens: Kane, La Salle, Peoria, Tazewell
Other reports: Du Page, Kendall, Vermilion
Last historic collection: 1957 Tazewell

This species was collected recently (Bowles 686, MOR, 1987) at a LaSalle Co. location where it had been previously known to occur. No search was made at other reported locations.

Viola incognita Brainerd
Known specimens: Cook, Jo Daviess, Kane
Other reports: McHenry (new: Lake)
Erroneous reports: De Kalb (specimen from cultivated source)
Last historic collection: 1958 Jo Daviess

This species was collected in 1981 at a new location in Cook Co. (Evert 2573, MOR), and in 1985 it was reportedly collected for the first time in Lake Co. (Snydacker 53, pers. comm.). It was not found during searches of other historic collection sites conducted in the course of this study.

Viola viarum Pollard
Known specimens: Adams
Other reports: Peoria
Erroneous reports: Kankakee (misidentification)
Last historic collection: 1970 Adams

This species was collected in Adams Co. in 1984 (Henry 4740, WMI) at an abandoned home site near the Mississippi River. It had been collected at the same location in 1970 and 1982. Additional work is needed to determine if natural populations occur in the vicinity of this station.

Woodwardia virginica (L.) J.E. Smith
Known specimens: Lake
Other reports: none
Last historic collection: 1947 Lake

This species is known from sphagnum bog habitat at a single Lake Co. site, where it was collected as late as 1947. That locality has now been seriously altered by drainage. The species has not been found in recent searches of the site, and it is presumed to be extirpated from the state.

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Some Aspects of the Status and Ecology of Seven Rare Wetland Plant Species in the Chicago Region of Northeastern Illinois

Marlin L. Bowles

The Morton Arboretum
Lisle, IL 60532

ABSTRACT

This report examines the Illinois status of seven endangered (E) or threatened (T) wetland plant species considered for listing status changes by the Illinois Endangered Species Protection Board in 1987. During 1988, populations of *Carex atherodes* (E), *C. crawei* (E), *C. rostrata* (E), *Cladium mariscoides* (T), *Eleocharis rostellata* (T), *Galium labradoricum* (T), and *Triglochin palustris* (E) were studied in order to collect voucher specimens, quantify population characteristics, and determine levels of protection and endangerment. These species were found to be obligate wetland species with a wide range of population and associated plant community characteristics. The overall number of known extant populations was increased by more than 200% from 34 to 108, with half of the new records for the sedge *Carex atherodes*; 88% of all populations are now represented by voucher specimens, and 75% of all populations were sampled. A high potential for population loss was found; almost half of the sites examined were endangered or threatened by development or by ecological problems. The number of extant populations was quantified in terms of an Effective Number ($N^{\sim}$), which assesses the viability of sites and populations in terms of developmental and ecological threats. Resultant status changes made by the Illinois Endangered Species Protection Board include endangered to threatened for *Carex atherodes* and *Carex crawei*, and delisting from threatened for *Cladium mariscoides*. Based on recent population decline, lack of new populations, and low population numbers, two additional wetland species (*Rhynchospora alba* and *Tofieldia glutinosa*) would appear to qualify for status changes from threatened to endangered.

INTRODUCTION AND PROBLEM

Northeastern Illinois wetlands are highly modified and reduced examples of a once extensive habitat. These remnants still support a unique set of plants and animals, including 69 endangered or threatened Illinois plant species (Bell 1981). Such habitats and their associated species are susceptible to various and subtle ecological changes, and are under severe impact nationally from intensified agriculture and urban land use (Andelin 1984). As a result of increasing development in northeastern Illinois, the listing status of endangered and threatened wetland plant species in this region appears to be in need of review and update.

In 1987, based on a literature and herbarium search, and personal communication, status changes for 71 endangered and threatened (Sheviak 1981) plant taxa were proposed (Bowles 1987) to the Illinois Endangered Species Protection Board. Included in this group were seven species (Table 1) thought to be more abundant than formerly known (Schennum 1980, 1981; Bowles 1987, but which are obligate wetland plants (Wilhelm 1988) in the Chicago region of northeastern Illinois. These species were deferred from status changes because it was felt that available data and voucher specimens were not yet adequate to justify new listings, and that additional field data were needed to help support listing decisions.

The Morton Arboretum was contracted to survey the status of these seven species in northeastern Illinois during the 1988 growing season. Objectives were to 1) document the existence of populations by collecting voucher specimens, 2) estimate plant abundance and size of populations, 3) assess levels

of protection and endangerment for habitats and populations of these species, and 4) develop listing recommendations for these species. An important objective in developing listing recommendations was to develop a method for quantifying habitat and population viability in relation to total numbers of populations. This paper presents a summary of the original report (Bowles 1988) to the Illinois Endangered Species Protection Board.

METHODS

All known Illinois stations for these seven species were determined from the endangered and threatened plant registry cards compiled by the original endangered species project (Sheviak 1981) and updated by the Morton Arboretum (Bowles 1987). During 1988, an attempt was made to visit each site from which populations of these species were reported, and to search for new populations in likely habitats. Procedures included collection of voucher specimens, characterization of natural plant communities (*sensu* White 1978), listing frequent plant associates (*sensu* Swink and Wilhelm 1979), and quantifying population sizes, abundance, and reproductive status of the species in question. Nomenclature follows Swink and Wilhelm (1979).

Populations of *Triglochin palustris* were quantified from continuous adjacent square-meter quadrats along transects; all other species were sampled with square meter quadrats at 5-meter intervals along linear transects through the plant populations. When species occurred in discrete habitats, the sizes of areas occupied by the populations were estimated, based on their length and width. Frequency of each species was determined by presence per 1/4 square meter within each sample quadrat.

Reproductive status was quantified for five species. The numbers of flowering or fruiting culms (individual plants may have multiple culms) were determined per square meter for *Carex atherodes*, *C. rostrata*, and *Cladium mariscoides*, and per single 1/4 square meter in each quadrat for *Carex crawei*; the number of reproductive plants per square meter was determined for *Triglochin palustris*.

A quantitative index was used to aid assessment of the population status of each species. The Effective Number (N^{-}) of populations of each species was determined in relation to levels or categories of protection and endangerment of each population. In calculating N^{-}, the current protection status (X_i) of each population was assigned to one of three levels: 1) preserved = dedicated Illinois Nature Preserve, 2) protected = in public or private ownership and recognized as a natural area, or 3) unprotected in public or private ownership. Threats of population endangerment (Y_i) were assigned similar scores: 1) stable = under no apparent threats, 2) threatened = with potential for significant population decline from impact by development, drainage, succession, or exotic species, or 3) endangered = with more immediate potential for population loss by similar conditions. These scores were combined into the Effective Number of Populations (N^{-}) by the formula:

> N^{-} = the sum of $2/(X_i+Y_i)$ over all values of X_i and Y_i, which are the respective protection and endangerment status scores for each site at which the species is extant. For example, the N^{-} for stable populations within four dedicated nature preserves would be $2/(1+1) \times 4 = 4.0$; while the N^{-} for four unprotected, endangered populations would be $2/(3+3) \times 4 = 1.333$, an effective number of just over one population.

When making listing recommendations, N^{-} provides a more realistic index of the number of viable extant populations. Comparison among species of their N^{-}:N ratios (where N = actual number of sites) represents an expression of their relative levels or threats of endangerment; species with smaller ratios have greater potential for population decline. N^{-}:N ratios for the above example are 4.0/4.0 = 1, and 1.33/4.0 = 0.325 for protected and unprotected species populations, respectively.

In order to make listing recommendations using N^{-} values, they were applied to the listing criteria used by the original endangered species project (Sheviak 1981), which recommended endangered status for plant species occurring in no more than six localities and likely of becoming extirpated in the near future; threatened species were considered likely to become endangered in the near future. In comparison, the

Illinois Natural Heritage Program state element ranking S1 (5 or fewer occurrences, limited numbers, or vulnerability) is similar to endangered status, while the S2 ranking (6-20 occurrences, limited numbers, or vulnerability) is similar to threatened status.

County voucher specimens are housed currently at the Morton Arboretum (MOR), County duplicates will be sent either to the Illinois State Museum (ISM) or the Illinois Natural History Survey (ILLS). All populations were mapped on copies of 7.5' USGS topographic maps; these maps are maintained in the project files.

RESULTS AND DISCUSSION

Numbers of populations

As a result of this and previous studies (*i.e.* Schennum 1980, 1981; Sheviak 1981; Bowles 1987), 108 extant populations were documented from 72 northern Illinois stations (Table 2) for the seven plant species in question. However, in all cases, the effective number (N^-) of populations for each species was reduced, with values ranging 33-43% less than actual numbers (Table 2). These new records represent an increase of over 200% from the 34 populations known prior to 1981. Ninety-six of the populations were vouchered by specimens, while 83 were sampled for population data (Tables 3 through 9). These discoveries are a product of increased botanical inventories in the Chicago region of Illinois, especially as a result of natural area and wetland preservation and management actions. Also, unusually dry field conditions in 1988 facilitated inventories and discoveries in sites that are normally inundated and difficult to traverse during the growing season. However, these conditions enhanced early senescence of *Carex crawei*, limiting data collection and discoveries of new populations. Similarly, dry panne conditions at Illinois Beach, Lake Co., may have prevented rediscovery of *Triglochin palustris*.

Almost fifty percent of the new records were for the sedge *Carex atherodes*, which is now known to occur in at least 36 stations (with N^-= 20.63) in eight counties (Table 2, Figure 1), an increase from only two historic county records. This plant also is known from a single Shelby County station in central Illinois that was not included in the study. *Carex atherodes* flowers infrequently, but the presence of pubescence on outer leaves and leaf sheaths (Swink and Wilhelm 1979) allows simple field identification of sterile plants, and has facilitated new population discoveries.

The remaining six species all had at least two or more new records (Table 2, Figure 1). *Carex crawei* populations now are known from 15 stations (N^-= 10.23) in six counties; the ten new extant populations included several rediscoveries of historic occurrences. *Carex rostrata* records increased from a single 1981 record in northeastern Illinois to ten populations (N^-= 7.23) in four counties (several reports were found to have been based on misidentification of *Carex vesicaria* var. *monile*). *Cladium mariscoides* was recorded from five new sites, an increase to 14 known extant populations (N^-= 9.23) in three counties. *Eleocharis rostellata* records increased from five stations in three counties to ten extant populations (N^-= 6.56) in four counties. Six new *Galium labradoricum* stations were recorded, with 17 populations (N^-= 10.40) now known extant in three counties. Puff (1977) also indicated a central Illinois record for this bedstraw that could not be mapped on a county basis; the population probably was in Marshall, Peoria, or Tazewell Co., and has not been relocated. *Triglochin palustris* records were increased from four to six known extant populations (N^-= 4.00) in three counties.

Population characteristics

Carex atherodes (Table 3) - As in Iowa (van der Valk and Davis 1979) and Manitoba, (Welling *et al.* 1988), this sedge was found to occupy (and sometimes dominate) zones above the deeper portions of glacial pot-hole marshes, or the borders of floodplain marshes. In Illinois, populations range in area from 10 m^2 to 2700 m^2 (mean = 832.27 m^2). The plant is usually abundant (mean = 79% frequency); it may form monotypic stands or colonies, and can persist in disturbed wetlands. It often occurs with the more frequent *Carex lacustris*. Other common associates in marshes include *Acorus calamus*, *Calamagrostis canadensis*, *Carex haydenii*, *Carex lanuginosa*, *Carex sartwellii*, *Lysimachia thyrsiflora*, *Polygonum amphibium* var. *stipulaceum*, *Polygonum coccineum*, *Sagittaria latifolia*, *Scirpus acutus*, *Scirpus validus* var.

creber, *Sparganium eurycarpum*, *Typha latifolia*, and *Typha angustifolia*. *Carex atherodes* also occurs rarely in sedge meadows, associating with *Calamagrostis canadensis*, *Carex stricta*, *Dryopteris thelypteris* var. *pubescens*, *Galium labradoricum*, and the introduced *Lythrum salicaria*, or in fens with *Calamagrostis canadensis*, *Carex stricta*, *Eupatorium maculatum*, and *Solidago gigantea*.

This is a relatively large perennial sedge; it reproduces vegetatively by rhizomes, and contributes seed bank propagules that germinate during drawdowns (van der Valk and Davis 1979, van der Valk 1981). As a result, annual sexual reproduction probably is unimportant for short-term population maintenance, and was not observed in 32% of the sampled populations. However, flowering culm production reached 8.9 culms/m^2 in some sites, and averaged 1.7 culms/m^2 over 25 populations, suggesting that Illinois populations are contributing to a seed bank.

Carex crawei (Table 4) - This sedge occupies calcareous prairies as well as wetland panne and fen habitats. It reaches its greatest abundance in pannes bordering the foredunes of Lake Michigan, where the plants are abundant (up to 88% frequency) in an extensive habitat. Here, associates include *Carex garberi*, *Eleocharis compressa*, *Juncus balticus* var. *littoralis*, and *Potentilla anserina*. This sedge occupies wet-mesic dolomite prairie in the Des Plaines River Valley, in association with *Deschampsia caespitosa* var. *glauca*, *Eleocharis compressa*, and *Poa compressa*. These populations also may be extensive, especially in disturbance patches, with up to 96% frequencies. *Carex crawei* occurs rarely in mesic prairies, where associates include *Habenaria leucophaea*, *Liatris pycnostachya*, *Panicum virgatum*, *Silphium terebinthinaceum*, and *Solidago riddellii*. In this habitat, it occurs in small to large (75 m^2 - 1300 m^2) colonies, often within disturbance patches, where frequencies may reach 100%. This sedge also is reported from marl flat borders of graminoid fens (G. Wilhelm pers. comm.), but no population data were collected during this study.

Carex crawei is a small, stoloniferous perennial (Fernald 1950) sedge, apparently forming large colonies by this process. Fruiting culms are evidently always present and often abundant (mean = 56 culms/m^2), with extremely high densities (over 200/m^2) in disturbance patches. However, the role of seed production or seed banks in population maintenance is not well known.

Carex rostrata (Table 5) - This is a northern sedge of low nutrient peatlands and lakeshores with relatively stable water levels (Keddy 1983, Lieffers 1984). In Illinois, var. *utriculata* is a rare component of marshes bordering pot-holes, floodplains, sedge meadows, and calcareous floating mats. Most populations are small (1000 m^2 or less in size); however, this sedge is usually very abundant (mean = 83.2% frequency) within populations. Associates are similar in all habitats and include *Acorus calamus*, *Calamagrostis canadensis*, *Carex stricta*, *Carex lacustris*, *Lythrum salicaria* (introduced), *Phragmites communis* var. *berlandieri*, *Polygonum amphibium* var. *stipulaceum*, *Polygonum coccineum*, *Sagittaria latifolia*, *Scirpus fluviatilis*, and *Sparganium eurycarpum*.

As with *Carex atherodes*, *C. rostrata* is a large rhizomatous perennial sedge; its individual shoots live 1-2 years before flowering (Gorham and Somers 1973, Bernard 1976). This species colonizes after fluctuating water levels, or fires, with germination from a seed bank, or after seed dispersal (van Der Valk and Davis 1978, Lieffers 1984, DeBenedetti and Parsons 1984). Flowering/fruiting culms occurred in all Illinois populations sampled (mean = 4.0 culms/m^2), evidently contributing to seed banks.

Cladium mariscoides (Table 6) - The twig-rush is a northern and eastern species of minerotrophic fens and marl flats (Bernard *et al.* 1985) and intermediate exposures along calcareous lakeshores (Keddy 1983). It is an obligate calcareous wetland species in Illinois, occurring in pannes along Lake Michigan, and in calcareous seeps (often association with the marl flats of graminoid fens). It is a dominant (White 1978) and very abundant species of pannes, reaching 100% frequency in extensive linear patterns along beach swales. Associates in this habitat include *Carex buxbaumii*, *Dryopteris thelypteris* var. *pubescens*, *Eriophorum angustifolium*, *Hypericum virginicum* var. *fraseri*, *Juncus balticus* var. *littoralis*, *Lythrum alatum*, *Polygonum amphibium* var. *stipulaceum*, *Scirpus americanus*, and *Triglochin maritima*. *Cladium mariscoides* is a characteristic species of calcareous seeps (White 1978), where it is usually less abundant than in pannes, but may reach

high frequencies locally. In this habitat, frequent associates include *Carex sterilis*, *Dryopteris thelypteris* var. *pubescens*, *Eleocharis rostellata*, *Lysimachia quadriflora*, *Muhlenbergia glomerata*, *Potentilla fruticosa*, *Silphium terebinthinaceum*, *Solidago ohioensis*, *Solidago uliginosa*, *Scirpus acutus*, *Scirpus americanus*, *Scirpus validus* var. *creber*, and *Triglochin maritima*.

Cladium mariscoides is a stoloniferous perennial; populations are maintained through vegetative reproduction (Bernard *et al.* 1985), while seed production contributes to colonization of early successional habitats (Seischab and Bernard 1985). Seed production appears to be high in Illinois populations (mean = 4.2 fruiting culms/m^2); however, these sites are usually stable, and seedling establishment may be important only in disturbed sites.

Eleocharis rostellata (Table 7) - This spike-rush occupies Atlantic coast salt marshes, minerotrophic fens, and nutrient-poor marl flats (Glaser 1983, Seischab *et al.* 1985). In Illinois it is characteristic of calcareous seeps (White 1978), where it is a very abundant (mean = 80.2% frequency) species. Typical associates include *Carex sterilis*, *Cladium mariscoides*, *Eupatorium perfoliatum*, *Lysimachia quadriflora*, *Potentilla fruticosa*, *Scirpus acutus*, *Scirpus validus* var. *creber*, *Solidago ohioensis*, and *Solidago uliginosa*.

Eleocharis rostellata forms tussocks and spreads vegetatively by rooting and proliferating from the tips of sterile culms (Fernald 1950). As in *Cladium mariscoides*, this spike-rush maintains stable populations by vegetative reproduction but colonizes successional marl flats (Seischab and Bernard 1985). Such colonization occurs either by seed dispersal or tip layering of the 1-meter long culms, with seed production indicative of more stressful environments (Seischab and Bernard 1985). Most Illinois populations are typified by layering culms, and apparently occupy more stable habitats.

Galium labradoricum (Table 8) - The northern bedstraw is a rhizomatous (Fernald 1950) diploid species of circumneutral soils (Puff 1977). In Illinois, it is now restricted to three closely related wetland communities in three extreme northeastern counties. Frequencies in these habitats rarely exceed 50%, and plants often are restricted to narrow zones within communities. It occurs locally in calcareous portions of sedge meadows with *Aster puniceus*, *Bromus ciliatus*, *Calamagrostis canadensis*, *Carex stricta*, *Dryopteris thelypteris* var. *pubescens*, *Eupatorium maculatum*, *Galium trifidum*, *Lathyrus palustris*, *Lycopus americanus*, *Lysimachia quadriflora*, *Pycnanthemum virginianum*, *Salix candida*, and *Solidago uliginosa*. It is usually infrequent in calcareous floating mats, associating with *Betula pumila*, *Campanula aparinoides*, *Carex lasiocarpa*, *Carex buxbaumii*, *Dryopteris thelypteris* var. *pubescens*, *Eupatorium maculatum*, *Menyanthes trifoliata* var. *minor*, *Potentilla fruticosa*, *Salix candida*, *Salix pedicellaris* var. *hypoglauca*, *Scirpus americanus*, *Solidago uliginosa*, and *Triglochin maritima*. It occurs rarely in bogs, but was frequent (51% frequency) in one extensive graminoid bog community, associating with *Betula pumila*, *Decodon verticillatus*, *Dryopteris thelypteris* var. *pubescens*, *Drosera intermedia*, *Galium trifidum*, *Lathyrus palustris*, *Liparis loeselii*, *Potentilla palustris*, *Salix candida*, *Salix pedicellaris* var. *hypoglauca*, *Scirpus acutus*, *Sphagnum* sp., and *Vaccinium macrocarpon*.

Triglochin palustris (Table 9) - Although reported from Lake Co. pannes along Lake Michigan, during this study the slender bog arrow grass was found only in calcareous seeps, where it is a characteristic plant (White 1978). In this habitat, it is infrequent to abundant (mean = 42% frequency) in usually small (mean = 12.7 m^2) areas of open spring runs. Most associates are more typical of adjacent calcareous seep vegetation, and include *Carex hystricina*, *Carex viridula*, *Deschampsia caespitosa* var. *glauca*, *Eleocharis elliptica*, *Equisetum arvense*, *Juncus brachycephalus*, *Parnassia glauca*, *Potentilla fruticosa*, *Rhynchospora capillacea*, *Scirpus acutus*, *Solidago ohioensis*, and *Tofieldia glutinosa*. This perennial spreads vegetatively by bulb-bearing stolons (Fernald 1950), with reproductive plants reaching densities of over 14 stems/m^2.

STATUS AND LISTING RECOMMENDATIONS

Wetland status

By 1981, 62% of the remaining high-quality examples of northeastern Illinois wetlands were threatened with modification or destruction (Bell 1981). During the 1980's these impacts have

continued and are now escalating in the rapidly developing Chicago region of Illinois. Wetlands receive some protection from development through Army Corps of Engineers and Environmental Protection Agency regulations. However, total watershed protection is not provided, and the majority of permit applications are not denied. The amended Illinois Endangered Species Protection Act now requires agency consultation on permit applications involving state-listed species, but agreements are not binding.

Among the 72 sites examined during this study, only 23 (32%) are dedicated Illinois Nature Preserves, while 19 sites remain totally unprotected from development (Table 2). In addition, over half (54.2%) of all sites examined (including at least seven Nature Preserves) are either threatened or endangered with drainage, development, succession due to fire protection, or invasion by exotic species such as *Lythrum salicaria*, *Phalaris arundinacea*,or *Rhamnus frangula*, . Also, threats to wetland sites often can impact suites of endangered or threatened species. Over one-third of all sites examined supported two or more of the seven species studied here, in addition to other listed species that were not studied. For example, alteration of a Kendall Co. graminoid fen resulted in apparent loss of the co-occurring species *Eleocharis rostellata* and *Triglochin palustris*, along with the state-listed *Mimulus glabratus* var. *fremontii*.

The management and protection needs of endangered or threatened obligate wetland species should be considered when developing listing-criteria for these species. Populations that occur in habitats with poor protection and management, or with development and ecological threats, have lowered viability, requiring protection of a relatively greater number of habitats to insure species survival. Under these conditions, calculation of an effective number of populations (N^-) provides quantitative support in assigning species to an appropriate current listing status category. When N^- is used association with qualitative evaluations, it can provide a more useful and defendable assessment of species-listing status.

Population status and listing recommendations

In response to original listing status recommendations (Bowles 1987), and the additional information provided in the initial status report on the seven wetland species (Bowles 1988), the Illinois Endangered Species Protection Board updated the Illinois list of endangered and threatened plant species in 1989 (Illinois Endangered Species Protection Board 1989). The Board also made subsequent listing changes for several species considered in this paper. These new listings are summarized below and in Table 2; county distribution maps are provided in Figure 1.

Carex atherodes - Although at least 36 populations of this sedge are now known, the effective number of populations is $N^- = 20.63$, with the lowest N^-:N ratio among species reviewed here. Six sites are dedicated Nature Preserves, and 20 of the 36 known stations are threatened or endangered by destruction, woody plant succession, or invasion by the exotics *Lythrum salicaria*, *Phalaris arundinacea*, and *Rhamnus frangula*. At least ten Chicago region stations have been proposed for development; as a result, N^- could drop below 20.0 in the near future. Because of the high number of known populations, the Illinois Endangered Species Protection Board removed this species from listing as endangered. It was retained as threatened because of the inordinately high number of populations under ecological or developmental threats.

Carex crawei - Only five of the known 15 populations of this sedge are protected as Nature Preserves, and six populations are threatened or endangered from woody succession, drainage, flooding, or development. As a result, the effective number of populations is $N^- = 10.23$. Although it remains somewhat widespread, this small plant is rare and often found only in small colonies. The pannes and dolomite prairies supporting larger populations of this sedge are restricted to Lake Co., and the Des Plaines River Valley of DuPage, Kankakee, and Will counties, respectively. This sedge was removed from listing as endangered because of the increase in number of known populations and large sizes of some populations. However, it was retained as a threatened species because of its overall rarity, lack of site protection, and ecological threats to many populations.

Carex rostrata - Variety *utriculata* is restricted to four counties in northeastern Illinois, where populations are usually small, and occur in a single natural

community. Extant records for this sedge were increased from one to ten populations and nine of the Illinois stations are protected. However, the effective number of populations is $N^{-} = 7.23$ because of widespread ecological threats such as from purple loosestrife, drainage, and fire protection. Although the number of known populations was increased, the Illinois Endangered Species Protection Board maintained listing of this species as endangered because of its usual small population size, restriction to a single community type, and ecological threats.

Cladium mariscoides - This sedge is restricted to three extreme northeastern Illinois counties, with fifteen known extant records. The majority of populations are protected and stable, and an extensive community dominant population occurs in pannes along Lake Michigan. The effective number of populations was reduced to $N^{-} = 9.23$ because of threats to some populations. The Illinois Endangered Species Protection Board removed this species from listing as threatened because of the high number and large size of protected populations.

Eleocharis rostellata - Although only three of the ten Illinois populations are within dedicated Nature Preserves, most appear stable, and the effective number of populations is $N^{-} = 6.56$. Because of the large number of apparently stable populations, this species was maintained by the Illinois Endangered Species Protection Board as threatened. However, most populations are small and restricted to a fragile habitat dependent upon proper management and stable, pollution-free, minerotrophic, ground water. As a result, effective or actual population sizes could be easily reduced in the near future, and the status of this species should be monitored frequently. For example, a population at an unmanaged Kendall Co. station was lost since 1977 after successional changes.

Galium labradoricum - This bedstraw is restricted to a specific micro-habitat in only three Illinois counties. Although more than 80% of the 17 populations are protected, the effective number is low ($N^{-} = 10.4$) because over 70% of the stations are threatened or endangered with impacts that could result in population loss. Habitat invasion by *Lythrum salicaria* is a major problem, while invasion by *Rhamnus frangula* is a threat to disturbed or unmanaged sites. As a result, this species was retained as a threatened species.

Triglochin palustris - Five of the six known stations ($N^{-} = 4.0$) for this species are either protected or are in relatively stable condition. However, the total area of spring-run habitat occupied by this species is extremely small and very fragile, and population maintenance appears dependent upon a continuous supply of unpolluted minerotrophic groundwater. One unmanaged Kendall Co. population was recently lost after successional changes. As a result, this species was retained as state endangered.

<u>Additional recommended status changes</u>

Two additional species were recommended for listing changes from threatened to endangered because of their obligate wetland status, lack of newly reported populations, recent apparent loss of populations, and relatively low effective population numbers (Bowles 1988). Although the Illinois Endangered Species Protection Board (1989) retained these species as threatened, it is recommended that their status be reviewed frequently to determine if population loss or decline is occurring.

Rhynchospora alba - This obligate wetland species (Wilhelm 1988) occurs in sphagnum bogs, graminoid fens, and pannes, with seven modern stations ($N^{-} = 4.73$) known from three Illinois counties (Sheviak 1981) and no new records. One site record (Thornton-Lansing Woods Nature Preserve, Cook Co.) is not represented by a voucher specimen, and a second site (Cedar Lake Bog Nature Preserve, Lake Co.) has declined in natural quality and may no longer maintain this species.

Tofieldia glutinosa - The false asphodel is an obligate wetland species (Wilhelm 1988) of fens and pannes in four counties (Sheviak 1981). It is extant at seven stations ($N^{-} = 5.50$) in Illinois, and no new populations have been reported. It has not been relocated at Braidwood Sand Prairie Nature Preserve, Will Co., nor at the South Elgin Sedge Meadow, Kane Co. station, which has been degraded by peat mining, drainage, and invasion by *Lythrum salicaria*.

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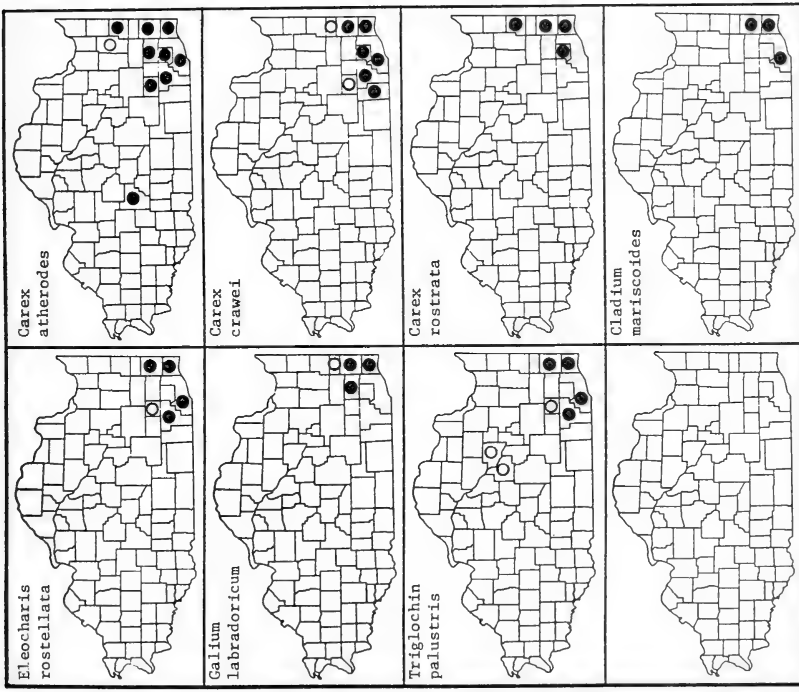

Figure 1. Illinois distributions of seven wetland plant species.
Closed circle = population(s) extant
Open circle = population(s) presumed extirpated

Table 1. Original listing status prior to field study for seven wetland plant species of the Chicago region of northeastern Illinois.

SPECIES AND VARIETY	ORIGINAL STATUS
Carex atherodes Spreng.	Endangered
Carex crawei Dew.	Endangered
Carex rostrata Stokes var. *utriculata* (Boott) Bailey	Endangered
Cladium mariscoides (Muhl.) Torr.	Threatened
Eleocharis rostellata Torr.	Threatened
Galium labradoricum Wieg.	Threatened
Triglochin palustris L.	Endangered

Table 2. Summary of current status and threats, known extant records (N) in 1981 (Sheviak 1981), effective numbers of populations (N^{-}), and current and recommended listing status for seven wetland species proposed for status changes.

CATEGORY	Carex atherodes	Carex crawei	Carex rostrata	Cladium mariscoides	Eleocharis rostellata	Galium labradoricum	Triglochin palustris	[TOTAL]	(%)
Extant records (1981)	0	5	1	9	5	9	4	[33]	(30)
Populations (1988)									
Preserved populations	6	5	5	4	3	9	2	[34]	(31)
Protected populations	17	8	4	7	6	5	3	[50]	(46)
Unprotected populations	13	2	1	3	1	3	1	[24]	(22)
Stable populations	16	9	6	7	4	5	3	[50]	(46)
Threatened populations	11	3	3	5	6	6	2	[36]	(33)
Endangered populations	9	3	1	2	0	6	1	[22]	(20)
Confirmed by voucher (1988)	33	12	10	12	9	14	6	[96]	(88)
Sampled in 1988	25	9	9	10	9	14	6	[82]	(75)
Total extant populations (1988)	36	15	10	14	10	17	6	[108]	
Effective numbers of populations (N^{-})	20.63	10.23	7.23	9.23	6.56	10.40	4.00		
Ratio of N^{-}:N	0.57	0.68	0.72	0.66	0.66	0.61	0.67		
Original listing (Sheviak 1981)	Endangered	Endangered	Endangered	Threatened	Threatened	Threatened	Endangered		
Final listing (Endangered Species Protection Board)	Threatened	Threatened	Endangered	Delisted	Threatened	Threatened	Endangered		

Table 3. Area, frequency, and density for 25 *Carex atherodes* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based on m^2 quadrats; all data were collected at 5-meter intervals along linear transects through *C. atherodes* populations. No. of m^2 plots and standard deviations are given in parentheses.

County/area	Population area & No. m^2 plots	Frequency per 1/4m^2	Culm density per m^2 (+-sd)
DuPage/#1	2500 m^2 (21)	83.3%	4.9/m^2 (5.3)
DuPage/#2	525 m^2 (10)	100%	2.3/m^2 (3.6)
DuPage/#3	260 m^2 (5)	100%	0.0/m^2
DuPage/#4	25 m^2 (5)	25%	0.0/m^2
DuPage/#5	2000 m^2 (24)	45.8%	0.0/m^2
DuPage/#6	30 m^2 (6)	45.8%	5.0/m^2 (4.5)
DuPage/#7	1600 m^2 (8)	100%	0.4/m^2 (0.5)
DuPage/#8	364 m^2 (5)	100%	5.6/m^2 (4.3)
Grundy/#1	500 m^2 (6)	95.5%	1.2/m^2 (2.3)
Kane/#1	2000 m^2 (10)	97.7%	2.8/m^2 (4.4)
Lake/#1	300 m^2 (10)	45%	0.4/m^2 (1.0)
Lake/#2	400 m^2 (10)	92.5%	0.5/m^2 (0.7)
Lake/#3	190 m^2 (5)	70%	2.2/m^2 (3.3)
Lake/#4	2000 m^2 (20)	70%	2.2/m^2 (3.3)
Lake/#5	2700 m^2 (18)	55.5%	0.0/m^2
Lake/#6	300m^2 (12)	81.25%	0.7/m^2 (1.6)
Lake/#7	2500 m^2 (13)	90.4%	0.4/m^2 (1.1)
Lake/#8	10 m^2 (3)	100%	0.0/m^2
Lake/#9	300 m^2 (6)	96.4%	8.9/m^2 (5.9)
Lake/#10	500 m^2 (5)	45%	0.0/m^2
Lake/#11	500 m^2 (10)	52.2%	2.2/m^2 (3.9)
McHenry/#1	150 m^2 (5)	100%	1.6/m^2 (1.4)
McHenry/#2	400 m^2 (5)	92%	0.0/m^2
McHenry/#3	15 m^2 (4)	100%	2.0/m^2 (4.0)
Winnebago/#1	750 m^2 (10)	100%	0.0/m^2
Column means	832.7 m^2	79.3%	1.7/m^2
Standard deviations	(900.30)	(24.0)	(2.0)

Table 4. Area, frequency, and density for 10 *Carex crawei* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based on single 1/4 m^2 quadrats within each m^2 quadrat. All data were collected at 5-m intervals along linear transects through *C. crawei* populations. No. of plots and standard deviations are given in parentheses.

County/area	Population area & No. m^2 plots	Frequency per 1/4m^2	Density per 1/4m^2 (+-sd)
Cook/#1	1300 m^2 (15)	65%	5.5 (10.1)
DuPage/#1	1000 m^2 (10)	53%	16.2 (16.8)
DuPage/#2	500 m^2 (4)	100%	50.2 (38.2)
DuPage/#3	1250 m^2 (3)	100%	6.3 (6.7)
DuPage/#4	75 m^2 (2)	88%	21.5 (13.4)
Lake/#1	1000 m^2 (6)	88%	7.8 (7.4)
Lake/#2	125,000 m^2 (19)	77.6%	7.3 (8.1)
Will/#1	10,000 m^2 (6)	96%	15.2 (30.9)
Will/#2	1000 m^2 (5)	65%	6.4 (8.6)
Will/#3	700 m^2 (6)	63%	3.2 (3.6)
Column means	14,182.5 m^2,	79.6%	14.0
Standard deviations	(39,044.9)	(17.2)	(14.0)

Table 5. Area, frequency, and density for 9 *Carex rostrata* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based on m^2 quadrats. All data were collected at 5-m intervals along linear transects through *C. rostrata* populations. No. of m^2 plots and standard deviations are given in parentheses.

County/area	Population area & No. m^2 plots	Frequency per $1/4m^2$	Culm density per m^2 (+-sd)
DuPage/#1	500 m^2 (8)	88.95%	2.4/m^2 (2.8)
DuPage/#2	100 m^2 (5)	100%	1.5/m^2 (1.1)
Lake/#1	1000 m^2 (8)	75%	8.15/m^2 (9.9)
Lake/#2	25 m^2 (7)	100%	10.1/m^2 (6.0)
McHenry/#1	15 m^2 (4)	100%	4.25/m^2 (2.5)
McHenry/#2	10 m^2 (4)	75%	1.75/m^2 (2.9)
McHenry/#3	5000 m^2 (10)	90%	2.7/m^2 (2.2)
McHenry/#4	1000 m^2 (11)	100%	4.3/m^2 (2.0)
McHenry/#5	1000 m^2 (15)	20%	0.5/m^2 (1.4)
Column means	961.1 m^2	83.2%	4.0/m^2
Standard deviations	(1579.1)	(25.9)	(3.2)

Table 6. Sample size, frequency, and density for 11 *Cladium mariscoides* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats), and flowering culm density is based in m^2 quadrats. All data were collected at 5-meter intervals along linear transects through *C. mariscoides* populations. No. of m^2 plots and standard deviations are given in parentheses.

County/area	Transect length & No. m^2 plots	Frequency per $1/4m^2$	Culm density per m^2 (+-sd)
Cook/#1	110 m (22)	59%	2.8/m^2 (4.3)
Lake/#1	50 m (10)	80%	4.1/m^2 (3.7)
Lake/#2	75 m (15)	100%	7.5/m^2 (5.5)
Lake/#3	50 m (10)	50%	2.7/m^2 (5.8)
Lake/#4	50 m (10)	20%	0.8/m^2 (1.9)
Lake/#5	50 m (10)	80%	7.5/m^2 (9.3)
McHenry/#1	50 m (10)	50%	6.0/m^2 (11.4)
McHenry/#2	75 m (13)	85%	11.6/m^2 (15.8)
McHenry/#3	10 m (3)	100%	1.3/m^2 (0.6)
McHenry/#4	50 m (11)	50%	1.3/m^2 (2.2)
McHenry/#5	50 m (11)	55%	1.7/M^2 (2.4)
Column means	56.3 m	66.3%	4.2/m^2
Standard deviations	(24.50)	(24.7)	(3.4)

Table 7. Sample size and frequency for 8 *Eleocharis rostellata* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats); all data were collected at 5-meter intervals along linear transects through *E. rostellata* populations. Standard deviations are given in parentheses.

County/area	Transect length	No. of m^2 plots	Frequency per 1/4 m^2
Cook/#1	110 m	10	87.5%
Lake/#1	50 m	10	77.5%
Lake/#2	10 m	4	70%
Lake/#3	5 m	2	87.5%
McHenry/#1	75 m	15	60%
McHenry/#2	50 m	10	87.5
McHenry/#3	50 m	40	90%
Will/#1	25 m	5	85%
Column means	46.9 m		80.2%
Standard deviations	(34.6)		(10.4)

Table 8. Sample size and frequency for 14 *Galium labradoricum* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats); all data were collected at 5-meter intervals along linear transects through *G. labradoricum* populations. Standard deviations are given in parentheses.

County/area	Transect length	No. of m^2 plots	Frequency per 1/4 m^2
Kane/#1	50 m	10	42.5%
Lake/#1	50 m	10	50%
Lake/#2	75 m	15	35%
Lake/#3	75 m	15	23%
Lake/#4	50 m	10	47.5%
Lake/#5	50 m	10	55%
Lake/#6	100 m	20	24%
Lake/#7	25 m	5	10%
Lake/#8	100 m	20	22.5%
McHenry/#1	50 m	10	10%
McHenry/#2	125 m	27	51%
McHenry/#3	150 m	32	37.5%
McHenry/#4	75 m	15	28.3%
McHenry/#5	50 m	10	27.5%
Column means	73.2 m		33.1%
Standard deviations	(34.6)		(14.7)

Table 9. Area, frequency, and density for 6 *Triglochin palustris* populations. Frequency is based on presence per 1/4 m^2 (within m^2 quadrats) and density is based on m^2 quadrats; all data were collected at 5-meter intervals along linear transects through *T. palustris* populations. No. of plots and standard deviations are given in parentheses.

County/area	Population area (No. m^2 plots)	Frequency per 1/4 m^2	Stem density per m^2 (+-sd)
Cook/#1	6 m^2 (6)	25%	7.0/m^2 (15.1)
McHenry/#1	7 m^2 (7)	71.4%	14.4/m^2 (17.1)
McHenry/#2	38 m^2 (38)	26.3%	7.0/m^2 (15.1)
McHenry/#3	4 m^2 (4)	37.5%	4.5/m^2 (3.8)
McHenry/#4	8 m^2 (8)	65.6%	12.4/m^2 (13.2)
Will/#1	13 m^2 (8)	26.9%	3.15/m^2 (3.4)
Column means	12.7 m^2	42.0%	7.0/m^2
Standard deviations	(12.8)	(21.1)	5.3

Book Reviews

Kirt, R.R. 1989. Prairie Plants of Northern Illinois: Identification and Ecology. Stipes Publ. Co., Champaign, IL. Price: $7.00 (paperback).

This paper bound booklet is written as a beginners identification guide to 63 important northern Illinois prairie plants. However, Kirt has gone beyond this to share ecological information and bits of prairie lore that every student of prairie should know. There are illustrated explanations of milkweed pollination and discussions of the composite, legume and grass families. The family accounts cover nitrogen fixing root nodules in legumes and growth form and structure of grasses.

Of the 63 plants covered, 11 are grasses, 1 is a sedge, and the others are forbs. Each species is illustrated with a reasonably good line drawing by Henrietta Tweedie or Roberta Simonds. After notation of the size, flowering date, flower color, and preferred moisture level, non-technical information is provided to aid in identification. This is followed by species specific "ecological notes" which include items such as the response of a species to disturbance, its indicator value in evaluating the quality of a prairie, its vulnerability to grazing, and its food value to wildlife.

Another helpful feature is a flowering date chart which shows at a glance which species are apt to be flowering on a given date. A glossary and list of selected references is also included.

All in all, it is one of the best beginners guides to prairie plants that I have come across.--*John E. Schwegman, Botany Program Manager, Illinois Department of Conservation, Springfield, IL 62701.*

Young, D. 1986. Wild Plants and Natural Areas of Kane County. Illustrated by Nan Mortensen. Kane County Environmental Department, 719 S. Batavia Ave., Geneva, IL 60134. 250 pp. Price: $10.00 (paperback).

If you find Swink and Wilhelm's Plants of the Chicago Region difficult to use because of the technical language and lack of illustrations, and you like Peterson and McKenny's A Field Guide to Wildflowers but find it doesn't cover our area thoroughly enough, then here is just the book for you.

Dick Young has taken the over 1200 plants that grow in Kane County, had them illustrated by Nan Mortensen, and arranged them according to the color of their flowers (like Peterson and McKenny). Voila! Here is a book easy enough for a beginner to use and complete enough for an experienced botanist to find useful.

For each species illustrated, the entry begins with the common name followed by a number (1-10) referring to its value in relation to all other plants, based on the comparative contribution it makes to the richness and stability of the community in which it lives. The Latin name comes next, followed by frequency, habitat, a brief description, and bloom dates.

Plants are grouped first as: Ferns and Fern Allies, Trees and Shrubs, Vines, Aquatics, Sedges, Grasses, Rushes, then flowers according to their flower color. Within each color designation, the plants are grouped according to flower type, beginning with the monocots (lilies, orchids, etc.) and proceeding taxonomically to the composites.

The first 167 pages of the book (including the 7 page introduction) contain all the drawings and plant descriptions. The rest of the book (pp. 168-231) contains a location map and description for each of 37 natural areas in the county. For each area the size, location, natural-areas-rating-evaluation number, community type, and preliminary species list are given. The last 17 pages are an index with both Latin and common names and a chart to help determine the identity of plants in fruit or berry.

There are no complicated keys or technical words to confuse the beginner, just illustrations (a picture is worth a 1000 words) and brief descriptions. The book is small and designed to take into the field. It can tell you where to find the natural areas in Kane

County and help you identify the plants you find in them. And of course it is useful throughout the whole Chicago area as well.

There are many things I like about this book: its completeness for our area, its illustrations, including silhouettes of the trees, as well as their leaves and flowers; its inclusion of grasses, sedges, and rushes; and its message to protect our native plants and their dwindling habitats.

The only criticism I have of this book pertains to the map (p.168) of natural areas. If each natural area was coded with a number instead of being represented by a star, it would not be necessary to look up coordinates to determine the locations of these slides. I use Wild Plants and Natural Areas of Kane County as a textbook for all my wildflower classes at the College of DuPage.--*Patricia K. Armstrong, Prairie Sun Consultants, 612 Staunton Road, Naperville, IL 60565.*

Guidelines for manuscripts submitted to Erigenia for publication

Manuscripts pertaining to the native flora of Illinois, natural areas, gardening/landscaping with native plants, new distribution records, threats to native species, and related topics are accepted for publication. At least one author must be a member of the Society, otherwise a $25.00 fee will be charged. Non-technical articles from the membership are encouraged.

Manuscripts should be double-spaced throughout with 1 inch margins on all sides; three copies should be submitted. Pages should be numbered, and tables and figures should be numbered consecutively. Longer articles should follow as much as much as possible this general format: abstract, introduction, materials and methods, results, discussion, summary, acknowledgements, and literature cited. Authors are requested to follow the CBE Style Manual. Journals in the literature cited section should be spelled out completely.

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U.S.D.A. Forest Service
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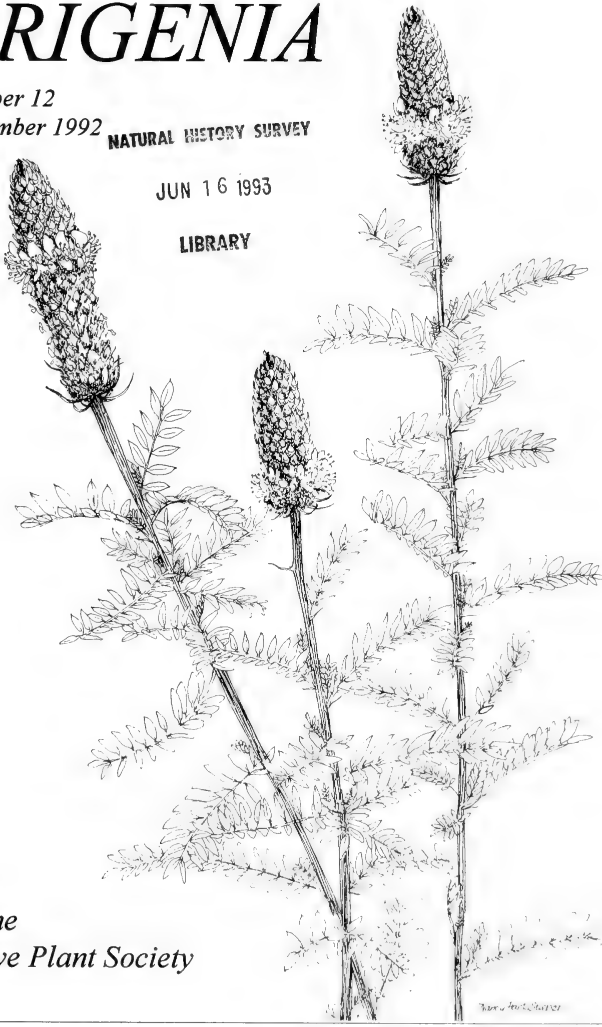

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The Illinois Native Plant Society is dedicated to the preservation, conservation and study of the native plants and vegetation of Illinois.

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Cover: *Petalostemum foliosum* Gray (synonym: *Dalea foliosa* (Gray) Barneby), leafy prairie clover, a federally endangered plant, was once widespread in northern Illinois but is now known from only four sites in one county.

This issue's cover illustration is a tribute to Floyd Swink for his many contributions to our understanding the flora of Illinois. Floyd's dedication to his work and his compassion for nature have influenced many of us to follow in his footsteps.

Woody Vegetation Survey of Barkhausen Woods, a Closed Canopy Sand Forest in Mason County, Illinois

David T. Coates, Sean E. Jenkins, and John E. Ebinger

Botany Department
Eastern Illinois University
Charleston, IL 61920

and

William E. McClain

Natural Heritage Division
Illinois Department of Conservation
Springfield, IL 62706

ABSTRACT

An inventory of the woody vegetation of a 4 ha section of a closed canopy sand forest in Mason County, Illinois gave a stand composition of 237.9 stems/ha (above 10 cm dbh), and a basal area of 16.3 m^2/ha. A total of 26 woody species were encountered, 3 were canopy trees, 14 were understory trees, and 9 were shrubs and vines. Black oak was the leading dominant with 77% of the basal area, 35% of the individuals, and with an importance value (IV) of 111.2 (out of 200). Black hickory ranked second (IV of 61.5), followed by blackjack oak (IV of 22.0). The more mesic species were not very common, restricted to the seedling and sapling layers, and a few individuals in a lower diameter class. Black oak and black hickory, however, dominate the seedling and sapling layer as well and the lower diameter classes, ensuring the future replacement of veteran trees.

INTRODUCTION

The vegetation of the inland sand deposits of Illinois was first studied by Gleason (1910), who listed the vascular plants and the plant associations. Later, Maier (1976) listed the vascular plants of Sand Ridge Forest in Mason County, Illinois, defined their habitats, assessed their abundance, and recorded flowering times. He found that many of the species and associations described by Gleason (1910) were either absent or scarce. He suggested a lowered water table and man's activities as possible explanations for these observations, stating that numerous plantings (particularly of exotics) and fencerows had decreased the amount of wind-blown sand, altering the delicately balanced successional processes.

Rodgers and Anderson (1979) studied the presettlement vegetation of Mason County, using General Land Office survey records. They found that prairie had been the dominant vegetation type, occupying 67.7% of the county. Savanna (14.4%) and forest (13.3%) occurred on most of the remaining land, while 4.6% of the area was covered by lakes and swamps. The dominant tree species in the presettlement forests and savannas were shade-intolerant, fire-tolerant oaks and hickories. In the closed canopy forests, tree densities were very high (263 trees/ha), the oaks and hickories were still the most numerous species, but more mesic, shade-tolerant, fire-sensitive tree species (*i.e.*, sugar maple, elms, black walnut) were also present.

Other studies in Mason County forests (Anderson and Brown 1983, 1986) determined the effect of fire in sand savannas and adjacent forests. They concluded that fire stabilized open forests, prairies, and savannas but tended to destabilize closed canopy forest systems, and that the absence of fire in the

present century has made closed canopy forests more common. Recently Jenkins *et al.* (1991), determined the species composition and structure of Bishop's Woods, a closed canopy sand forest in Mason County, Illinois. They found *Quercus velutina* Lam. (black oak), *Carya texana* Buckl. (black hickory), and *Q. marilandica* Muenchh. (blackjack oak) were the most common, with lesser amounts of more mesic species.

The present study of a closed canopy sand forest on the Barkhausen Conservation Area was undertaken to determine the floristic composition and structure of the forest, to determine its similarity to other forests of the sand areas of Illinois, and to examine some of the environmental parameters that may be responsible for its present structure and composition.

DESCRIPTION OF THE STUDY AREA

Barkhausen Woods, 18.2 ha (45 acres) in size, is located 10 miles SW of Bath in the extreme SW corner of Mason County, Illinois (NW1/4, Sec. 19, T19N, R10W) in the Illinois River Section, Illinois River and Mississippi River Sand Areas Natural Division (Schwegman 1973). The woods is nearly flat, varying in elevation from 140-146 m above sea level, with a stabilized sand dune at the southern margin rising to about 6 m above the rest of the area. The soils are sandy and were developed from deep sand deposits laid down by glacial meltwaters during the Pleistocene (Willman and Frye 1970, Schwegman 1973, Maier 1976). This closed canopy oak-hickory forest was probably more open in the past, and presently shows no sign of logging or grazing. Donated to the Illinois Department of Conservation in the early 1960's, it is now called the Barkhausen Conservation Area.

MATERIALS AND METHODS

During the summer of 1989, a 4 ha section of the Conservation Area was divided into quadrats 25 m on a side. The number, size and species of all living and dead standing trees (above 10 cm dbh) were recorded for each of the 64 quadrats. The relative dominance, relative density, and importance value (IV) were then calculated for each species. IV determination follows the procedure developed by McIntosh (1957) and later by Boggess (1964), and is the sum of the relative density and relative dominance of a given species. The average diameter (cm), density (#/ha) in broad diameter classes; and basal area (m^2/ha) were also calculated for each species.

Nested circular plots of 0.0001, 0.001, and 0.01 ha in size were randomly located in each of the 64 quadrats. Seedlings under 40 cm in height were tallied in the 0.0001 ha plots; seedlings more than 40 cm in height but less than 2.5 cm dbh were recorded in the 0.001 ha plots; and saplings (2.5-10.0 cm dbh) were recorded in the 0.01 ha plots, and their densities (#/ha) determined. Nomenclature follows Mohlenbrock (1986).

Soil pits were randomly located within the woods to determine depth of the A horizon, and soil samples were taken to determine the pH and soil texture of both A and B horizons. The soil pH was measured using a Corning pH meter (Model 7). Soil texture was determined using the Bouyoucos Hydrometer Method (Bouyoucos 1962).

RESULTS AND DISCUSSION

A total of 26 woody species was recorded in the forest, of which 3 were canopy trees, 14 were understory trees, and 9 were shrubs and vines. The tree species encountered, along with their densities in broad diameter classes, basal area, relative values, importance values, and average diameters are listed in Table 1.

Black oak was first in importance (IV of 111.2) having the highest relative dominance (76.7), and ranked second in relative density (34.5). It was common in all diameter classes, 62% of the individuals exceeded 4 dm dbh, and it had the highest average diameter (41.3 cm dbh) of all species present. It also accounted for 77% of the total basal area in the woodlot, ranked first in the seedlings/ha, and second in saplings/ha (Table 1).

Black hickory, second in importance (IV of 61.5), had the highest relative density (Table 1). It was common in the lower diameter classes, with 81% of its individuals in the 1-2 dm class, and had the lowest average diameter of the overstory species (15.9 cm dbh). It ranked third in seedlings/ha and first in saplings/ha, accounting for 64% of the saplings

encountered.

Blackjack oak ranked third with an IV of 22.0, being third in both relative dominance and relative density (Table 1). It was relatively common in the lower diameter classes and had an average diameter of 19.1 cm dbh. It ranked second in seedlings/ha, but very few saplings were encountered. This species had a clumped distribution, being found at the margins of openings, and associated with the stabilized dune at the southern edge of the forest.

The other tree species were of minor importance, accounting for a combined IV of 5.3. Most were found in the seedling, sapling, and 10-20 cm diameter class. Of these species *Catalpa speciosa* Warder ex Engelm. (catalpa) was the most common, followed by *Prunus serotina* Ehrh. (wild black cherry), and *Gleditsia triacanthos* L. (honey locust). These species were usually found in areas where past tree-falls had created canopy openings.

Multiple-stemmed trees (coppices) were relatively common, averaging 15.3 coppice trees/ha, 35.3 stems/ha, and a basal area of 2.0 m^2/ha. Blackjack oak accounted for 41% of the coppice growth with an average of 6.3 trees/ha and 2.5 stems/tree. Black oak accounted for 26% of the coppice growth but made up 65% basal area, with the average stem being 42.5 cm dbh. Black hickory accounted for 30% of the coppice growth but only accounted for 11% of the total basal area.

Tree mortality averaged 26.8 dead-standing trees/ha, with an average diameter of 33.6 cm dbh and a basal area of 2.7 m^2/ha. Black oak had the highest mortality with 18.5 trees/ha, and an average diameter of 39.3 cm dbh, accounting for 69% of the dead trees and 89% of the basal area. Blackjack oak, second in mortality with 5.8 stems/ha, had an average stem size of 20.7 cm dbh, while black hickory accounted for only 9% of the dead trees.

Nine shrubs were encountered in the understory and averaged 9235 stems/ha. *Toxicodendron radicans* (L.) Kuntze (poison ivy) at 4438 stems/ha, *Rubus allegheniensis* Porter (blackberry) at 2125 stems/ha, and *Cornus racemosa* Lam. (gray dogwood) at 1203 stems/ha were the most common, accounting for 84% of the total stems. These species were most common in canopy openings, and were usually clumped. *Ribes missouriense* Nutt. (Missouri gooseberry), *Rhus aromatica* Ait. (fragrant sumac), *Zanthoxylum americanum* Mill. (prickly ash), and *Rubus occidentalis* L. (black raspberry) were occasionally encountered.

The soils in the woodlot at the Barkhausen Conservation Area were extremely sandy and acidic. The A horizon throughout the area had an average depth of 7.8 cm and an average pH of 4.9, while the B horizon had an average pH of 4.6. Soil texture averaged 89.5% sand, 8.1% silt, and 2.4% clay in the A horizon,, while the B horizon averaged 92.5% sand, 5.4% silt, and 2.1% clay.

CONCLUSIONS

The results of this study indicate that Barkhausen Woods is similar to Bishop's Woods (Jenkins *et al.* 1991), another closed canopy forest in the Illinois River Sand Area Section. In both, the overstory was found to be dominated by black oak, black hickory, and blackjack oak, with mesic species being very uncommon in the overstory. Also, the stems/ha were nearly the same (237.9 for Barkhausen Woods, 247.5 for Bishop's Woods) as was the basal area (16.3 m^2/ha for Barkhausen Woods, 16.1 m^2/ha for Bishop's Woods). The major differences between the two woodlots were the importance of black hickory (22.6 in Bishop's Woods, 61.5 in Barkhausen Woods), and the absence of *Carya tomentosa* (Poir.) Nutt. (mockernut hickory) from Barkhausen Woods.

Both forests show some similarity to the closed canopy forests of the sand deposits of presettlement times. Rodgers and Anderson (1979) reported that the closed canopy forests associated with the sand deposits in Mason County were dominated by black oak (IV of 118.31), blackjack oak (IV of 18.35), and hickory spp. (IV of 21.81), with the remaining being mesic species. Barkhausen and Bishop's Woods have the same dominants as reported by Rodgers and Anderson (1979), but the more mesic species are mostly missing. Though present in small numbers in the understory, these species have not entered the canopy. This suggests that in the past these two forests were more open, and relatively recently, as a result of canopy closure, the more mesic species may be starting to increase in numbers. However, it is probable that the composition of these closed canopy forests will remain fairly stable in

composition. Presently, the relatively shade-intolerant dominant species tend to reproduce themselves. Black oak and black hickory have a large number of individuals in the lower diameter classes, and have sufficient seedlings and saplings for the future replacement of veteran trees.

Studies suggest that savannas in the Midwest often owe their sustainment to periodic fires, since, in the absence of burning, savannas are rapidly converted to closed canopy forests (Muir 1913, Cottam 1949, Curtis 1959). In many forests in the Midwest there are widely spaced, large, open-grown trees that are surrounded by smaller, forest-grown trees (Anderson and Brown 1983, Henderson and Long 1984, Ebinger and McClain 1991). It is now generally believed that many closed canopy forests originated from savannas when periodic fires were stopped as Europeans settled the region (Cottam 1949, Curtis 1959, Rodgers and Anderson 1979, Anderson 1982). This suggests that the closed canopy forest at the Barkhausen Conservation Area was originally more open, and in the absence of fire or other disturbances, has developed a closed canopy.

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Table 1. Densities (#/ha), diameter classes, basal areas (m^2/ha), relative values, importance values, and average diameters of the tree species in Barkhausen Conservation Area, Mason County, Illinois.

Species	Seedlings #/ha		Saplings	Diameter Classes (dm) #/ha						Basal Area	Rel.	Rel.		Av. Diam.
	<40cm	40cm	#/ha	1-2	2-3	3-4	4-5	5+	Totals	m^2/ha	Den.	Dom.	IV	(cm)
Quercus velutina Lam.	2500	859	139	11.3	7.3	12.8	25.8	25.0	82.2	12.5	34.5	76.7	111.2	41.3
Carya texana Buckl.	1406	844	564	89.3	16.5	3.0	0.8	--	109.6	2.5	46.2	15.3	61.5	15.9
Quercus marilandica Muenchh.	2188	609	20	22.3	10.8	1.5	1.0	--	35.6	1.2	14.9	7.1	22.0	19.1
others*	1096	797	153	10.0	0.5	--	--	--	10.5	0.1	4.4	0.9	5.3	--
Totals	7190	3109	876	132.9	35.1	17.3	27.6	25.0	237.9	16.3	100.0	100.0	200.0	

* Includes *Catalpa speciosa* Warder ex Engelm., *Sassafras albidum* (Nutt.) Nees, *Diospyros virginiana* L., *Ulmus americana* L., *Tilia americana* L., *Celtis occidentalis* L., *Morus rubra* L., *Amelanchier arborea* (Michx. f.) Fern., *Prunus serotina* Ehrh., *Gleditsia triacanthos* L., *Juniperus virginiana* L., *Ulmus rubra* Muhl., *Fraxinus americana* L., and *Betula nigra* L.

Woody Vegetation Survey of Sullivan Woods, Moultrie County, Illinois

Sandra S. Baumgartner, Sean E. Jenkins, Michael A. Jenkins, and John E. Ebinger

Botany Department
Eastern Illinois University
Charleston, IL 61920

ABSTRACT

An inventory was completed of the woody vegetation at Sullivan Woods, a dry mesic upland forest located in the Grand Prairie Natural Division of east central Illinois, Moultrie County. This forest, which is dominated by *Quercus alba* L., *Carya ovata* (Mill.) K. Koch, *Acer saccharum* Marsh., and *Ulmus rubra* Muhl., has a stand composition of 252 stems/ha, with an average basal area of 24.6 m^2/ha. *Quercus alba* accounts for 37% of the individuals (above 10 cm dbh) and 64% of the basal area. The understory is dominated by *Ulmus rubra*, which accounts for nearly 50% of the seedlings and saplings.

INTRODUCTION

Sullivan Woods (Pogue Timber) is located in the Grand Prairie Section of the Grand Prairie Natural Division (Schwegman 1973). It is located immediately north of the Shelbyville moraine, the terminus of Wisconsin glaciation, and is about 2 miles northeast of Findlay, Moultrie County, Illinois. Sullivan Woods, which is managed by the U. S. Army Corps of Engineers, is on part of the land purchased in the mid 1960's as upland buffer for Lake Shelbyville, a reservoir and flood control project built on the Kaskaskia River.

The woods is probably typical of relatively mature forests associated with the uplands along major rivers located in the Grand Prairie Natural Division of Illinois. Though more open and lacking mesophytic woody species in presettlement time, these forests have become closed and now have a more diverse woody flora, primarily due to the cessation of fire (Rodgers and Anderson 1979, Ebinger 1986). Typically, these relatively dry forests still maintain the dominant oak/hickory component, but more mesic species are slowly invading (Boggess and Geis 1966, Newman and Ebinger 1985, Ebinger 1986). A detailed study of Sullivan Woods was undertaken to determine its woody composition and structure.

DESCRIPTION OF THE WOODS

Sullivan Woods, about 12 ha in size, is located in the extreme southeastern corner of Moultrie County, Illinois (NW1/4 Sec 36 T13N R5E). It is on the uplands surrounding the extensive valley system of the Kaskaskia River drainage. The topographic relief within the site does not exceed 10 m, and the area is relatively flat except for two shallow valleys, one that traverses the northern part of the woods and one at the western edge. The woods is well drained, and the small valleys are dry except immediately after a rain. The woods is bordered by a county road on the north, an abandoned road on the east, and a successional field on the south. Some cut stumps are found scattered throughout the woods. Also, the woods was probably grazed before being purchased about 25-30 years ago.

MATERIALS AND METHODS

A 5-ha section of the woodlot was divided into quadrats 25 m on a side (80 quadrats), and all living and dead-standing woody individuals above 10 cm dbh were identified and their diameters determined. From these data the density (stems/ha), basal area (m^2/ha), relative values, importance value (IV), and average diameter were calculated for each species. The determination of the IV follows the procedure used by McIntosh (1957) and later Boggess (1964), and is the sum of the relative density and the relative dominance of a given species.

The composition and density (stems/ha) of the

woody understory were determined from nested circular plots 1/10,000, 1/1,000, and 1/100 ha in size. In the 1/10,000-ha plots small seedlings (<40 cm tall) were counted, in the 1/1,000-ha plots large seedlings (>40 cm tall but <2.5 cm dbh) were determined, and in the 1/100-ha plots the saplings (2.5-10 cm dbh) were tallied. Shrubs less than 40 cm tall were recorded in the 1/10,000-ha plots, while in the 1/1,000-ha plots the larger shrubs were tallied. Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

A total of 17 canopy and 4 understory species were identified in the woods. The most common of these, along with their seedling and sapling densities (stems/ha), relative density, relative dominance, importance value (IV), average diameter, and the number of stems/ha in broad diameter classes are listed in Table 1. The common shrubs encountered and their densities (stems/ha) are listed in Table 2.

Of the species encountered, *Quercus alba* (white oak) ranked first with an IV of 101.3 (out of a possible 200), and had the highest relative density and relative dominance. This species accounted for 37% of the individuals and 64% of the basal area of the woodlot and had an average diameter of 43.6 cm. It was common in all diameter classes, and more than 80% of the stems exceeded 30 cm dbh. It also was fairly well represented in the seedling category, averaging 875 stems/ha (Table 1). Besides white oak, other oak species were occasional canopy components. *Quercus velutina* (black oak), which ranked sixth in importance with an IV of 6.4, was relatively common in the drier parts of the woods, while *Q. rubra* (red oak), eighth in importance (IV of 4.8), was mostly restricted to mesic valleys. In disturbed upland sites a few *Q. imbricaria* (shingle oak) were encountered. Though not particularly abundant, seedlings and saplings of all oak species were found throughout the woodlot (Table 1).

Carya ovata (shagbark hickory) ranked second in importance with an IV of 25.6. This species accounted for 14% of the density and 11% of the basal area of the woodlot. It was common in most diameter classes, and averaged 1,293 seedlings/ha and 31.3 saplings/ha. Other hickory species were also relatively common overstory components. *Carya glabra* (pignut hickory), which ranked fifth in importance (IV of 10.8), occurred in all diameter classes and had an average diameter of 37.4 cm. This species was well represented in the seedlings category with more than 3,000 stems/ha. *Carya tomentosa* (mockernut hickory) and *C. ovalis* (sweet pignut hickory) were found on the drier upland and ranked seventh and ninth in importance, respectively, while *C. cordiformis* (bitternut hickory) was rarely encountered, being restricted to the mesic valleys.

The relatively mesic species *Acer saccharum* (sugar maple) and *Ulmus rubra* (slippery elm) ranked third and fourth respectively in importance. Both were well represented in the 10-20-cm diameter class, while only a few individuals were present in the larger diameter classes. Slippery elm seedlings and saplings were extremely common throughout the woods and accounted for nearly half of the seedlings (14,593 stems/ha), and more than one-third of the saplings (368.8 stems/ha). Sugar maple, in contrast, accounted for only 825 seedlings/ha and 73.8 saplings/ha. Both species appear to be increasing in importance in the woods, as they are the most common species in the 10-20-cm diameter class. The remaining species in the woods had extremely low IV's and, individually, had little impact on forest structure.

Tree mortality was relatively low in the woods, averaging 13 dead-standing stems/ha with an average basal area of 1.07 m^2/ha. As expected, white oak had the highest mortality with 7.4 stems/ha. Black oak was second with 1.4 stems/ha, followed by shagbark hickory and slippery elm. A few cut stumps were present; most appeared to be of white oak, black oak, and black walnut. Coppice stems were uncommon in the woods.

Of the understory trees present, only *Cercis canadensis* (redbud) was relatively common, being represented in the 10-20-cm diameter class, and averaging 1,100 seedlings/ha and 71.3 saplings/ha (Table 1). The three other understory species, *Ostrya virginiana* (hop hornbeam), *Morus rubra* (red mulberry), and *Crataegus mollis* (red haw) were only rarely encountered. The shrub layer through the woods was relatively dense and averaged 15,877 stems/ha (Table 2). *Rubus allegheniensis* (blackberry), *Toxicodendron radicans* (poison ivy), *Symphoricarpos orbiculatus* (coralberry), and *Ribes*

missouriense (Missouri gooseberry) were the most common shrub species found.

The data suggest that Sullivan Woods is in transition from a xeric oak/hickory forest to a more mesic forest in which sugar maple is increasing in importance. Oaks (particularly white oak) and hickories presently prevail in importance and are the common larger diameter trees (Table 1). They are also fairly common in the seedling and sapling categories and are represented in the smaller diameter classes. As a result, the oaks and hickories will continue to be an important component of the canopy, but sugar maple should increase significantly in importance due to its high gap-phase-replacement-potential, which will allow it to take advantage of canopy openings as the veteran trees die (Runkle, 1984). Slippery elm, though presently the most important species in the seedling, sapling and 10-20-cm diameter class, will probably not become an important canopy component due to Dutch elm disease, which will continue to limit its importance in the woods.

The layered structure of the understory suggests that the woods was heavily grazed before it was purchased as buffer for the reservoir. Also the presence of many thorny species in the relatively dense understory is an indication of a more open woods and of past grazing. The presence of cut stumps indicates that this woods was selectively cut just before purchase. The relatively even distribution of woody species, particularly white oak, in the 30+ cm diameter classes indicates a history of selective cutting throughout most of the past century. Since the cessation of grazing and cutting after protection in the mid 1960's, the forest canopy has closed, and a dense understory has developed.

Sullivan Woods is similar to the upland forest at the Rocky Branch Nature Preserve, Clark County, Illinois (Hughes and Ebinger 1973), and the upland forest at Walnut Point State Park, Edgar County, Illinois (Ebinger *et al.* 1977). These forests of the Grand Prairie Natural Division are on upland sites associated with rivers or large streams, have been disturbed in the past by cutting and grazing before protection, are dominated by white oak, have hickories as an important component, and have few mesic species except in the seedling, sapling, and smaller diameter classes. With canopy closure these woods are becoming more mesic, and sugar maple, slippery elm, American ash, and other shade-tolerant, fire-intolerant, mesophytic species will continue to increase in importance. Without management to keep the canopy open and to decrease the extent of the dense understory, Sullivan Woods, within the next 50 years, will become a maple/oak/hickory forest. As this occurs its woody composition will become similar to that found in Baber Woods Nature Preserve, Edgar County, Illinois, which is presently dominated by sugar maple (McClain and Ebinger 1968, Newman and Ebinger 1985).

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Table 1. Densities (#/ha), diameter classes, basal areas (m^2/ha), relative densities, relative dominances, importance values (IV), and average diameters of the tree species in Sullivan Woods, Moultrie County, Illinois.

Species	Seedlings #/ha		Saplings #/ha	Diameter Classes(cm) #/ha						Basal Area	Rel.	Rel.		Av. Diam.
	<40cm	>40cm	#/ha	10-20	20-30	30-40	40-50	50+	Total	m^2/ha	Den.	Dom.	IV	(cm)
Quercus alba L.	750	125	3.8	7.6	10.0	20.0	24.0	30.8	92.4	15.7	36.7	64.6	101.3	43.6
Carya ovata (Mill.) K. Koch	880	413	31.3	8.4	7.6	12.4	6.2	0.8	35.4	2.8	14.0	11.6	25.6	29.8
Acer saccharum Marsh.	500	325	73.8	24.6	5.8	0.4	0.4	0.2	31.4	0.7	12.5	3.1	15.6	15.9
Ulmus rubra Muhl.	9630	4963	368.8	32.4	1.0	--	--	--	33.4	0.5	13.3	2.0	15.3	13.1
Carya glabra (Mill.) Sweet	3000	363	7.5	1.2	2.4	3.4	3.4	1.8	12.2	1.5	4.8	6.0	10.8	37.4
Quercus velutina Lam.	630	150	12.5	3.2	0.4	0.2	0.6	2.6	7.0	0.9	2.8	3.6	6.4	33.3
Carya tomentosa (Poir.) Nutt.	130	300	51.3	2.0	2.8	2.4	1.4	0.2	8.8	0.7	3.5	2.7	6.2	28.7
Quercus rubra L.	--	13	10.0	0.8	0.4	0.2	0.4	2.2	4.0	0.8	1.6	3.2	4.8	44.7
Fraxinus americana L.	880	475	25.0	5.0	0.2	--	--	--	5.2	0.1	2.1	0.4	2.5	14.5
Carya ovalis (Wang.) Sarg.	380	138	6.3	--	--	1.0	1.2	--	2.2	0.3	0.9	1.2	2.1	40.1
Prunus serotina Ehrh.	2000	338	46.3	4.0	0.6	--	--	--	4.6	0.1	1.8	0.3	2.1	13.9
Celtis occidentalis L.	130	175	10.0	2.8	0.2	--	--	--	3.0	0.1	1.2	0.2	1.4	12.9
Ulmus americana L.	130	163	47.5	3.0	--	--	--	--	3.0	0.1	1.1	0.2	1.3	12.6
Cercis canadensis L.	1000	100	71.3	2.6	--	--	--	--	2.6	0.1	1.0	0.1	1.1	11.2
Sassafras albidum (Nutt.) Nees	630	75	36.3	2.2	--	--	--	--	2.2	0.1	0.9	0.1	1.0	11.3
Others*	880	590	71.3	2.6	0.8	1.2	--	--	4.6	0.1	1.8	0.7	2.5	--
Totals	21,550	8706	873.0	102.4	32.2	41.2	37.6	38.6	252.0	24.6	100.0	100.0	200.0	

* Includes *Carya cordiformis* (Wang.) K. Koch, *Juglans nigra* L., *Ostrya virginiana* (Mill.) K. Koch, *Morus rubra* L., *Crataegus mollis* (Torr. & Gray) Scheele, and *Quercus imbricaria* Michx.

Table 2. Density (stems/ha) of seedlings and mature stems of shrubs in Sullivan Woods, Moultrie County, Illinois.

Species	Seedlings <40 cm tall	Mature Stems >40 cm tall
Rubus allegheniensis Porter	5750	700
Toxicodendron radicans (L.) Kuntze	4125	363
Symphoricarpos orbiculatus Moench	1250	363
Ribes missouriense Nutt.	1000	475
Cornus racemosa Lam.	250	200
Viburnum prunifolium L.	125	50
Corylus americana Walt.	125	38
Rosa carolina L.	1000	--
Euonymus atropurpurea Jacq.	--	38
Rubus occidentalis L.	--	25
Totals	13,625	2252

Additions to the Flora of Ford County, Illinois

Don Gardner

Rt 2 Box 110
Kempton, IL 60946

Organized in east central Illinois in 1859, Ford was the last county to be established in the state. One would have expected that during the past century and one half virtually all of the plant species within the county would have been documented. Such, however, is not the case.

The Illinois Natural History Survey (INHS) provided the author a list of 480 taxa for Ford County from the Illinois Plant Information Network (ILPIN) data base. Numerous species known to occur in Ford County were missing from this list. During 1990, a search for unrecorded species was initiated. Voucher specimens were collected and deposited at the Illinois Natural History Survey Herbarium. Some proved to be interesting native plants such as *Lathyrus palustris* L. (marsh vetchling), *Polygala sanguinea* L. (field milkwort), and *P. verticillata* L. (whorled milkwort). Others were previously overlooked exotic weedy species, such as *Malva neglecta* Wallr. (common mallow) and *Mollugo verticillata* L. (carpet weed). One, *Carex hirta* L., is an addition to the state flora. All fill a gap in information about the plants of Illinois.

It is quite likely that there are significant numbers of species not recorded in other Illinois counties by ILPIN. Interested individuals are encouraged to check the data base for their county and to document prospective county records.

Collected specimens should be pressed in printed or unprinted newspaper and, if available, dried between blotters and cardboard ventilators. Information concerning description of the location (township, range, section, etc.), habitat, collector(s), collection number, and date of collection should be recorded. After drying, the specimens can be delivered to one of the herbaria in the state, such as the Illinois Natural History Survey. The identification will be confirmed, the specimen placed on file, and the new information added to the ILPIN data base.

For those not familiar with the preparation of herbarium specimens there is an excellent description of the procedure in INHS Circular 55, "Observing, Photographing and Collecting Plants" by Dr. Kenneth R. Robertson. It is available from INHS, 607 E. Peabody Dr., Champaign IL 61820. Keep in mind that when collecting plant specimens, permission from private land owners is necessary. Permits are required by some agencies such as County Forest Preserve Districts and National Forests. To apply for permits to these types of agencies, write or call their supervisors for the proper referral or procedure.

The era is long past when adventurous plant hunters roamed the West, sending large collections of previously unidentified plants to herbaria in the East and in Europe. However, it is still possible to capture a bit of that sense of discovery. It is hoped that others will join the search and that new plant records will be added to the listings in other counties.

There follows a list of thirty-five plant species recently added to the ILPIN data base for Ford County. Taxonomy follows Mohlenbrock (1986) except for *Carex hirta* (Gleason, 1952), *Aster lanceolatus* var. *simplex* (Jones, 1989), and *Euphorbia dentata* (Swink and Wilhelm, 1979).

NEW FORD COUNTY PLANT RECORDS

HABITATS, LOCATIONS, COLLECTION DATES AND COLLECTION NUMBERS

Alliaria petiolata (Bieb.) Cavara & Grande
Shaded ditch margin, low but increasing population
SW 1/4 NE 1/4 Sec 6 T28N-R9E
5 May 1990
#3

Anemone cylindrica Gray
Embankment, abandoned railroad right-of-way, numerous in restricted area
NW 1/4 NE 1/4 Sec 29 T29N-R9E
13 June 1990
#12

Antennaria neglecta Greene
Mowed cemetery, large population
NW 1/4 Sec 15 T28N-R9E
23 Apr 1990
#1

Asclepias viridiflora Raf.
Ballast, abandoned railroad right-of-way, infrequent
NW 1/4 NE 1/4 Sec 29 T29N-R9E
23 June 1990
#14

Aster laevis L.
Operating railroad right-of-way, scattered among other prairie taxa
SW 1/4 SW 1/4 Sec 15 T25N-R9E
25 Oct 1990
#30

Aster lanceolatus Willd. var. ***simplex*** (Willd.) A.G. Jones
Dense population in hedgerow of *Maclura pomifera* (Raf.) Schneider
NW 1/4 NW 1/4 Sec 8 T28N-R9E
17 Sept 1990
#29

Carex annectens Bickn.
Old field, former pasture, numerous
SW1/4 NW1/4 NE1/4 Sec 6 T28N-R9E
5 June 1991
#94

Carex hirta L.
Roadside, ditch margin, single dense population
SEl/4 NE1/4 NW1/4 Sec 6 T28N-R9E
22 May 1991
#49

Dichanthelium acuminatum (Sw.) Gould & Clark
Old field, former pasture, frequent
NW 1/4 NE 1/4 Sec 6 T28N-R9E
18 June 1990
#13

Eleocharis verrucosa (Svens.) Harms
Old field, former pasture, numerous
SW1/4 NW1/4 NE1/4 Sec 6 T28N-R9E
24 May 1991
#48

Ellisia nyctelea L.
Farm woodlot, fertile soil, low population
NW1/4 NW1/4 Sec 8 T28N-R9E
7 May 1991
#53

Erysimum cheiranthoides L.
Stable ditch margin, thinly scattered
SW1/4 NW1/4 NE1/4 Sec 6 T28N-R9E
11 May 1991
#59

Euphorbia dentata Michx.
Limestone ballast on abandoned railroad embankment, infrequent
NW 1/4 NE 1/4 Sec 29 T29N-R9E
25 Aug 1990
#22

Euphorbia marginata Pursh
Disturbed margin of wooded former village landfill, infrequent
NW 1/4 NE 1/4 Sec 6 T28N-R9E
14 Aug 1990
#19

Galinsoga quadriradiata Ruiz & Pavon
Recently cleared farm building site, common
NE 1/4 NE 1/4 Sec 19 T28N-R9E
21 Aug 1990
#21

Hypoxis hirsuta (L.) Coville
Abandoned railroad right-of way, low population among prairie species
NW 1/4 NE 1/4 Sec 29 T29N-R9E
17 May 1990
#4

Ipomoea hederacea (L.) Jacq.
Disturbed field margin, common
SW1/4 NW1/4 NE1/4 Sec 6 T28N-R9E
7 Aug 1991
#172

Lathyrus palustris L.
Low area, abandoned railroad right-of-way, locally rare
NW 1/4 NE 1/4 Sec. 29 T29N-R9E
13 June 1990
#11

Lithospermum arvense L.
Disturbed ballast, abandoned railroad right-of-way, uncommon
NW 1/4 NE 1/4 Sec 29 T29N-R9E
28 Apr 1990
#2

Lonicera tatarica L.
Wooded former village landfill, frequent
NW 1/4 NE 1/4 Sec 6 T28N-R9E
26 May 1990
#7

Malva neglecta Wallr.
Former barnyard, common
NW 1/4 NE 1/4 Sec 6 T28N-R9E
11 Sept 1990
#25

Mollugo verticillata L.
Invasive on tilled soil, common
NW 1/4 NE 1/4 Sec 6 T28N-R9E
15 Aug 1990
#20

Physalis heterophylla Nees.
Cultivated field margin, common
SE1/4 NE1/4 NW1/4 Sec 6 T28N-R9E
8 June 1991
#112

Phytolacca americana L.
In hedgerow of *Maclura pomifera*, thinly scattered population
NW 1/4 NW 1/4 Sec 8 T28N-R9E
21 July 1990
#17

Polygala sanguinea L.
Old field, untilled former pasture, low population restricted to site
NW 1/4 NE 1/4 Sec 6 T28N-R9E
17 July 1990
#16

Polygala verticillata L.
Old field, untilled former pasture, locally rare
NW 1/4 NE 1/4 Sec. 6 T28N-R9E
14 Aug 1990
#18

Rosa multiflora Thunb.
Roadside ditch bank, common
E 1/2 SE 1/4 Sec 6 T28N-R9E
12 June 1990
#10

Sida spinosa L.
Cultivated farm field, common
NE1/4 NE1/4 Sec 8 T28N-R9E
8 Aug 1991
#173

Silene noctiflora L.
Wooded former village landfill, infrequent
NW 1/4 NE 1/4 Sec 6 T28N-R9E
26 May 1990
#5

Solanum americanum Mill.
Aggressively weedy on margin of tilled field, abundant
NW 1/4 Sec 8 T28N-R9E
8 Sept 1990
#24

Solanum dulcamara L.
Vining on *Lonicera tatarica* hedge row
SE 1/4 NE 1/4 NW 1/4 Sec 6 T28N-R9E
16 Sept 1990
#27

Solidago graminifolia (L.) Salisb.
Operating railroad right-of-way with other *Solidago* species
SW 1/4 SW 1/4 Sec 6 T28N-R9E
7 Sept 1990
#23

Sonchus asper (L.) Hill
Ditch bank, frequent
NW 1/4 NW 1/4 Sec 8 T28N-R9E
2 July 1990
#15

Sporobolus asper (Michx.) Kunth.
Dry slope on railroad right-of-way, thinly scattered population
SE 1/4 SW 1/4 NW 1/4 Sec 6 T28N-R9E
16 Sept 1990
#28

Sporobolus heterolepis (Gray) Gray
Prospect Cemetery, numerous on site among mesic prairie associates
SW 1/4 SW 1/4 SW 1/4 Sec 17 T23N-R9-10E
27 Oct 1990
#31

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Changes in Illinois' List of Endangered and Threatened Plant Species

James R. Herkert

Illinois Endangered Species Protection Board
524 South Second Street
Springfield, IL 62701

and

Glen Kruse

Illinois Department of Conservation
524 South Second Street
Springfield, IL 62701

ABSTRACT

During 1989 and 1990 the Illinois Endangered Species Protection Board reviewed and updated the Illinois list of endangered and threatened plant species. This review resulted in a number of status changes for plants, the results of which are summarized in this report. Thirty-five species were added to the list, 43 species were removed from the list, 6 species had their status changed from endangered to threatened, and 3 species had their status changed from threatened to endangered. The net decrease of 8 species brings the total of endangered and threatened plant species in Illinois to 356 (296 endangered and 60 threatened). Persons wishing to obtain a complete listing of Illinois endangered and threatened species should contact the Illinois Endangered Species Protection Board, 524 South Second Street, Springfield, Illinois 62701. A listing of some pertinent references is given at the end of this paper.

SPECIES ADDED TO THE LIST

There were three primary reasons for adding species to the list during the recent revisions. Fifteen species were newly discovered in Illinois. Seven species were either thought to be extirpated or of unknown status and had been recently rediscovered in Illinois. Thirteen species were added on the basis of the availability of new information on the status of particular species. Several types of new information were considered, including the new identification of previously collected specimens and new information on species declines or rarity within Illinois. A listing of the 35 species added to the list follows. The status of each species is also given as LE - listed as endangered or LT - listed as threatened. Primary reasons for addition are also given (ND = newly discovered in Illinois, NI = new information regarding species status within Illinois, RD = recently rediscovered within Illinois).

Species	Status	Reason
Amelanchier sanguinea (Pursh) DC.	LE	ND
Aster furcatus Burgess	LT	NI
Astragalus crassicarpus Nutt. var. *trichocalyx* (Nutt.) Barneby	LE	RD
Besseya bullii (Eat.) Rydb.	LT	NI
Boltonia decurrens (Torr. & Gray) Wood	LT	NI
Carex brunnescens (Pers.) Poir.	LE	ND

Carex canescens L. var. *disjuncta* Fern.	LE	ND
Carex chordorrhiza L. f.	LE	RD
Carex echinata Murr.	LE	NI
Carex tuckermanii Boott	LE	ND
Carex willdenowii Schkukr	LE	ND
Cimicifuga americana Michx.	LE	NI
Cirsium pitcheri (Torr. & Eat.) Torr. & Gray	LT	NI
Clematis occidentalis (Hornem.) DC.	LE	ND
Collinsia violacea Nutt.	LE	NI
Corydalis curvisiliqua Engelm. var. *grandibracteata* (Fedde) Ownbey	LT	RD
Corylus cornuta Marsh.	LE	ND
Cyperus grayioides Mohlenbr.	LT	NI
Cystopteris laurentiana (Weath.) Blasd.	LE	NI
Equisetum scirpoides Michx.	LE	RD
Equisetum sylvaticum L.	LE	ND
Erythronium mesochoreum Knerr	LE	ND
Gymnocarpium robertianum (Hoffm.) Newm.	LE	ND
Liatris scariosa (L.) Willd. var. *nieuwlandii* Lunell	LT	NI
Lonicera dioica L. var. *glaucescens* (Rydb.) Butters	LE	ND
Milium effusum L.	LE	RD
Mirabilis hirsuta (Pursh) MacM.	LE	NI
Opuntia fragilis (Nutt.) Haw.	LE	RD
Oxalis illinoensis Schwegman	LE	NI
Penstemon brevisepalus Pennell	LE	ND
Rosa acicularis Lindl.	LE	ND
Silphium trifoliatum L.	LE	ND
Tomanthera auriculata (Michx.) Raf.	LT	NI
Vaccinium oxycoccos L.	LE	ND
Valerianella chenopodifolia (Pursh) DC.	LE	ND

SPECIES REMOVED FROM THE LIST

There were four main reasons for removing plants from the state list. Twenty-seven species were removed because they are now believed to be extirpated from Illinois. Five species are now known to be too common within Illinois to warrant listing as either endangered or threatened. Ten species were removed from the list because further study indicated that the specimens were initially misidentified and the species are now not believed to occur in Illinois. One species was determined to be adventive. In some cases there were multiple reasons for removing plants from the list. For example, a plant in which recent collections were misidentified, and in which other collections were very old might be listed as EX/MI. RE indicates removed from endangered, RT removed from threatened. Primary reasons for delisting are also given (EX = extirpated within Illinois, TC = considered too common to remain listed, MI = misidentification, AD = adventive).

Species	Status	Reason
Aralia hispida Vent.	RE	EX
Aristida necopina Shinners	RE	EX/MI
Bacopa acuminata (Walt.) Robins.	RE	EX/AD
Baptisia tinctoria (L.) Vent.	RE	EX
Carex cumulata (Bailey) Fern.	RE	EX
Carex plantaginea Lam.	RE	EX
Cinna latifolia (Trev.) Griseb.	RE	EX
Cladium mariscoides (Muhl.) Torr.	RT	TC

Daucus pusillus Michx.	RE	EX/AD
Dodecatheon amethystinum Fassett	RE	TC
Eleocharis equisetoides (Ell.) Torr.	RE	EX/MI
Eleocharis parvula (Roem. & Schult.) Link	RE	AD
Equisetum palustre L.	RE	EX/MI
Fuirena scirpoides Michx.	RE	EX
Geum rivale L.	RE	EX
Glyceria canadensis (Michx.) Trin.	RE	EX
Gnaphalium macounii Greene	RE	EX
Habenaria hookeri Torr.	RE	EX
Hydrastis canadensis L.	RT	TC
Hypericum boreale (Britt.) Bickn.	RE	MI
Lycopus amplectens Raf.	RE	MI
Onosmodium molle Michx.	RE	EX
Oxalis grandis Small	RE	MI
Panax quinquefolius L.	RT	TC
Panicum hians (Ell.) Nash	RE	MI
Panicum mattamuskeetense Ashe	RE	MI
Panicum nitidum Lam.	RE	MI
Paspalum lentiferum Lam.	RE	EX/MI
Philadelphus pubescens Loisel.	RE	EX
Phlox carolina L. ssp. *angusta* Wherry	RE	EX/MI
Physostegia intermedia (Nutt.) Engelm. & Gray	RE	MI
Plantago heterophylla Nutt.	RE	EX
Polygonum bicorne Raf. (formerly *P. longistylum* Small)	RE	TC
Pyrola secunda L.	RE	EX/MI
Ranunculus ambigens Wats.	RE	EX/MI
Rhynchospora macrostachya Torr.	RE	EX/MI
Rorippa truncata (Jepson) Stuckey	RE	EX/AD
Scirpus microcarpus Presl	RE	EX
Scirpus pedicellatus Fern.	RE	EX
Solidago remota (Greene) Friesner	RE	MI
Stachys clingmanii Small	RE	MI
Valerianella intermedia Dyal	RE	MI
Woodwardia virginica (L.) Sm.	RE	EX

SPECIES WITH A CHANGE IN STATUS

<u>Species Changed From Endangered To Threatened</u>

Aristolochia serpentaria L. var. *hastata* (Nutt.) Duchartre
Carex atherodes Spreng.
Carex crawei Dewey
Cirsium carolinianum (Walt.) Fern. & Schub.
Polygonatum pubescens (Willd.) Pursh
Rubus pubescens Raf.

<u>Species Changed From Threatened To Endangered</u>

Asplenium resiliens Kunze

Planera aquatica (Walt.) J. F. Gmel.
Polanisia jamesii (Torr. & Gray) Iltis

NOMENCLATURAL CHANGES

Former name	New name
Betula lutea Michx. f.	*Betula alleghaniensis* Britt.
Fimbristylis baldwiniana (Schultes) Torr.	*Fimbristylis annua* (All.) Roem. & Schult.
Polygonum longistylum Small	*Polygonum bicorne* Raf. (later de-listed)
Scleria reticularis Michx.	*Scleria muhlenbergii* Steud.

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Iliamna remota: An Illinois Native Returns Home

Larry R. Morrison[1]

110 Virginia Ave.
O'Fallon, Illinois 62269

Kankakee Mallow (*Iliamna remota* Greene) is a perennial herbaceous plant of the mallow family (Malvaceae). It grows to a height of six to seven feet; has leaves that are simple, alternate, lobed and toothed; and produces flowers that have five pale lavender-pink petals and a slightly sweet aroma. In Illinois, this mallow has been listed by the Illinois Endangered Species Protection Board as an endangered species and certified as such by Administrative Order of the Illinois Department of Conservation in April 1980. Nationally, the species is currently under review for listing under the federal Endangered Species Protection Act as in danger of extinction throughout its range.

In Illinois, this mallow occurs naturally at only one location, Langham Island in the Kankakee River, Kankakee County. It is also found at a few other scattered localities in the eastern United States. The current consensus among botanists, however, is that the locations other than the Kankakee site were probably started by plant lovers in the past, trying to expand the range of this rare and interesting species. One such non-Illinois location is along a railroad right-of-way in Botetourt County, Virginia.

A few years ago, a couple belonging to the Virginia Wildflower Preservation Society collected some Kankakee Mallow seeds from this Botetourt County site. My friends explained: "We would not normally take seeds from an endangered species but these plants had spread to a roadway where one plant had been run over and was beginning to wilt; therefore, we felt justified in taking one seed pod." They were able to get some of these seeds to germinate, and now have a flourishing colony of Kankakee Mallows in their wildflower garden in Roanoke, Virginia.

In January 1988, they sent me a handful of seeds and some very general instructions: "Plant now and winter in the ground." The Kankakee Mallow seed pod is a small, round receptacle which can be up to 1/2 inch in diameter. The pod is flattened on both ends, very hairy, and dark brown when ripe. The individual seeds are small (about 1/16 inch), dark brown, hard, and flat. Examined closely, they look like the beginning loop of a spiral.

At the time I was given these seeds, I knew very little about *Iliamna remota*, so I experimented with various techniques and garden locations, trying to discover an approach that would be successful. On January 16th, I sowed a quarter of the seeds (about four dozen) directly into several patches that I had prepared in different parts of the garden. Another quarter of the seeds was placed in plastic planting trays which were filled with a mixture of commercial potting soil and vermiculite. These trays were placed in a corner of the garden where they would not be disturbed. The remainder of the seeds were placed in the refrigerator as a back-up reserve.

The winter of 1988 was relatively mild, which may have affected the rate and time of germination, but on May 14th I noticed the first mallow seedlings in the plastic trays. There was a fairly good germination rate from the trays, resulting in about three dozen plants. On May 21st, the largest seedlings began producing their first true leaves and I transplanted the first plant directly into the garden in a location where it would receive full sun.

Over the next two weeks, I transplanted six other seedlings into the garden but under partial shade conditions. At the end of May, I offered the rest of the plants to the Missouri Botanical Garden with only one condition attached: If my own plants did not survive, I wanted at least one of the donated plants back. This offer was quickly accepted, even with my caveat. According to the latest information

[1]Dr. Morrison is an historian for the Air Force, but also very interested in our native flora.

that I have received (June 1992) the plants at the botanical garden were doing well and flowering.

On June 4th a few plants from seeds sown directly into my garden sprouted, but were promptly eaten by something. The transplanted seedlings adjusted well, but the one planted in full sun did the best. Throughout the summer there was only some slight insect damage: An occasional leaf edge eaten or the tracings left by a leaf miner. I had a fairly regular regimen of watering the garden because of the 1988 drought, so the lack of moisture should not have seriously affected the plants in my garden.

In early August I noticed flower buds appearing in the crown of the first plant, which was then about 2 1/2 feet tall. The first bloom opened on August 12th. The flower nearest the base of the plant opened first, with the others following in a set sequence of about one day after the preceding bloom faded. There was a total of five blossoms, all in the crown of the plant. Each one lasted about 2 1/2 days. I was surprised that any plant bloomed that first year, but the only one to bloom was the first seedling which had been transplanted into full sunlight. In the times I observed the plant, I did not see any flying insects visiting the blossoms, but small ants were often present, especially around the stamens clustered in the center of the flower. None of the flowers set seed that first year.

Despite early freezing temperatures and two inches of snow on November 20th, the mallows in 1988 were not killed until December 11th, when the temperature fell into the teens. That first year, none of the plants in my garden reached anywhere near the average height of five feet which they achieve in their native habitat. I assume this was because of the age of the plants rather than a reflection of the growing conditions. At the time the plants were killed by the freeze, the tallest plant was 29 inches, the shortest 11 inches. Interestingly, the size correlated exactly with the order the plants were transplanted; *i.e.*, the one transplanted first was the tallest; the last one was the shortest.

In early January 1989, I once again filled the plastic trays with a mixture of potting soil and vermiculite, sowed the reserve mallow seeds from 1988, and placed the trays in the same corner of the garden that had worked so effectively in 1988. Contrary to the experience of others, my germination rate was not as good the second year when less than half the seeds sprouted, but I still got several plants. I discovered later that in his work with *Iliamna remota*, John Schwegman has found that if the seeds are either scarified or soaked in warm water for 24 hours, there is a much better chance for germination.

In 1989, I put only one of the new plants in my own garden. I offered the rest to the Illinois Department of Conservation, hoping these plants might provide a little genetic diversity to the population on Langham's Island. A transfer of plants could never be arranged, but later the DOC did accept some seeds from my plants.

In corresponding with the Department of Conservation, I learned that the plan was not to intermix these non-Illinois origin plants with the ones on Langham's Island, but, instead, for comparison's sake, to grow representatives from the two populations near each other in a test plot.

By mid-February '89, perhaps because of the mild winter, small green rosettes were already appearing at the base of the mallow in the sunniest location of the garden. By late March all of the mallows were sending up new growth. In mid-April all the mallows seemed to be doing fine, but by the end of the month half of the older plants had died. I suspect that root rot brought about by heavy, wet, compacted soil caused this mortality. The other plants continued to do well.

The oldest plant, the one receiving full sunlight, always did the best. By mid-May, this plant had four stems, each about one foot tall, and already had small buds forming in the crown of each stem. On June 8th, four of the blossoms on the main stems opened. By the same time, the plant was also sending out lateral branches from these primary stems. Within a month, the other two-year-old plant was also flowering. Both plants bloomed prolifically all summer, often with six to eight flowers on the same branch open at once. By late summer, the number of new blossoms was greatly reduced, but one plant continued to bloom into early September.

At various times during the summer, these blossoms were visited by small bees and wasps, gnats, and

ants. However, considering the large number of blooms available, a surprisingly small number actually produced seeds. I wonder if poor seed production contributes to the rarity of this species? I collected the first ripe seeds on August 14th; the last ripe pod in early October. The two flowering two-year-old plants produced a total of only 26 ripened seed pods for the year. I gave all of these seed pods to the Illinois Department of Conservation, so I do not know whether there were, indeed, any truly viable seeds produced from my plants in 1989.

As in 1988, there was some small damage to the leaves by leaf miners in 1989, but no major problems. Indeed, the plants did quite well, especially the one in full sun. By the end of the year, when killed by temperatures in the teens in early December, the longest stem of that plant was 73 inches tall.

Except for a brief, brutal cold spell (-16 degrees Fahrenheit) in December, the winter of 89-90 was a mild, but dry one. Several times in January, the temperature was over 60 degrees. By the end of January, all the mallows were sending up new growth. Those plants in the full sun had expanded tremendously, and even the most shaded plant had more than doubled the number of stems. The oldest, largest, and healthiest specimen even produced a small plant, I assume by underground runner, some ten inches from the parent plant.

With one major exception, the story of 1990 was very similar to the earlier two years. The first bloom opened on June 10th; all the older plants were blooming by the end of June; even the new runner-produced plant bloomed in late August. The plants bloomed all summer, with the last flower opening on September 22nd. As in past years, the plants suffered very little insect damage. The tallest plant was 82 inches high when hit by killing temperatures in early December.

The critical exception in 1990 was with the oldest, and heretofore largest and healthiest, plant. It grew and bloomed normally until mid-June when the leaves on one of the stems began to wilt. Initially, I thought it was simply a case of not enough water, but increased watering did not help. The leaves continued to wilt, eventually turned brown and withered completely, then the stem itself finally died. Over the next few weeks, this condition spread to all the other stems of this plant. I could find nothing in the literature about diseases which affect *Iliamna remota*, so I have no answer as to what caused the problem. I cut all the dead stems off at ground level, hoping this might act as a preventive measure for the plants close by. For whatever reason, the other Kankakee Mallows growing nearby were not affected in 1990, but the next year the plant produced by runner from the diseased plant exhibited some of the same symptoms. Two stems from this plant wilted and died in late May, and the other stems showed some of the early leaf wilting problems, but then recovered. The plant grew slowly in 1991, but did begin blooming in early June, and by July had apparently beaten the problem. All the other mallows remained healthy, and continued to expand the number of blooming stems.

By 1990, I had Kankakee Mallows growing in two different locations in my garden. At one site, the mallows were basically by themselves. At the other location, however, a Kankakee Mallow was merely one plant among a host of other summer-flowering perennials, such as Black-Eyed Susan, Purple Coneflower, Shasta Daisy, Butterfly Weed, Bee Balm, Painted Daisy, and Prairie Gayfeather. In both 1990 and 1991, the latter mallow, the one growing among other flowers, produced a much larger number of seed pods than the mallows growing by themselves. I have not conducted any scientific experiments, but my assumption is that pollinators were initially attracted to the showier plants, then visited the mallow flowers almost incidentally while in the area. The mallows standing alone, on the other hand, apparently did not have a large enough or attractive enough display, on their own, to attract a large number of pollinators in the first place, and thus had a smaller percentage of flowers pollinated.

Despite the deep compacted snow and ice which covered the garden for several days during the winter of 1990-91, by the end of February '91 new growth was already appearing at the base of all the mallows. Moreover, every plant had increased its number of stems. The healthy mallows followed the same basic growth and bloom patterns that they had experienced over the last three years, except they started blooming a little earlier in 1991. The first

blooms opened on May 25th, and all the plants were flowering by June 7th. One plant was doing particularly well. By mid-June it had eight stems all over six feet tall, and with several lateral branches. At one point there were 18 blossoms open on one of these stems. By early July, when the initial draft of this article was written, there were even a few ripe seed pods ready. As in past years, the plants were finally killed by freezing temperatures in mid-winter.

In August 1992, when this final revision of this article was being prepared, the 1992 growing season had been a virtual repeat of the successful previous year. All the plants were doing well and producing seeds. Not only had the older plants grown additional stems from the old crowns, but three additional plants had been produced by underground runner. As before, the mallows growing with other, showier, plants were producing more seeds than those growing by themselves on the other side of the garden.

Based on my experiences, I assume that Kankakee Mallow, under normal conditions, would do well in any sunny garden with at least average soil. The only drawbacks to the plant for "normal" garden use are its height, and its tendency to look a little "weedy" by the end of the summer. However, its rarity, interesting blooms, and ease of cultivation more than make up for these weaknesses. More importantly, by growing a few plants in private gardens, we can help insure the species against extinction.

I cannot conclude without a brief comment regarding the ethics of seed collecting. Ideally, seeds should come from a friend or a seed exchange program that various organizations, such as the American Horticulture Society, run. If you must collect from the wild, do so very sparingly. The basic rule is do not overcollect. The Canadian Wildflower Society's guidelines, for example, state that no more than 10% of a wild seed crop should be collected. I think this figure is too high. It takes only a few people collecting their perceived 10% of the crop to wipe out a year's production. If you must collect from the wild, take just enough for your own immediate needs. Also you need to keep in mind that it is illegal to collect wild seeds from species on the federal endangered species list. For laws regarding the plants in your area, check with your local conservation officials.

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Author's Addendum: Overall in 1990, I collected over 200 ripened seed pods. I offered additional seeds to the Illinois Department of Conservation but since I never received a reply to my letter, I assume that personnel there wanted no more non-Illinois origin mallow seeds. In both 1990 and 1991, I gave some seeds to friends, but still had seeds left over. I have also begun collecting seeds from 1992 and assume I shall have a continuous supply of seeds over the next few years. If anyone would like to try raising some Kankakee Mallows, just send me a stamped, self-addressed envelope. I shall share seeds as long as the supply lasts.

Status and Population Fluctuations of the Eastern Prairie Fringed Orchid [*Platanthera leucophaea* (Nutt.) Lindl.] in Illinois

Marlin Bowles and Robyn Flakne

The Morton Arboretum
Lisle, Ilinois 60532

and

Russ Dombeck

Northeastern Illinois University
Chicago, Ilinois 60625

ABSTRACT

Historically, the federal threatened eastern prairie fringed orchid [*Platanthera leucophaea* (Nutt.) Lindl.] reached its greatest abundance in Illinois, occurring in 33 counties throughout the northern two-thirds of the state. Most Illinois populations now occur in loess soils over glacial till or outwash in both upland and wetland habitats. Over a twelve-year period (1980-91), statewide censuses of all known populations ranged from 4 to 313 flowering plants, with plants appearing more consistently in wetland sites and during years of high rainfall. This suggests that wetland habitat may be critical in maintaining populations, and that long-term monitoring is needed to understand population dynamics better. Twenty-one populations are extant in Illinois, nineteen of which are in six Chicago-region counties. These populations represent a 75% decline in extant county records, and probably a far greater overall decline in total numbers of plants. Using an artificial viability index based on population size, habitat size, community successional stage, legal protection, and management needs, we concluded that only one Illinois population currently has high viability. Several other populations can be made highly viable through management and protection. We suggest that successful long-term management of Illinois populations will depend upon maintenance of late-successional prairie conditions, primarily through burning, and may also require artificial management for regeneration niches. Continued monitoring, both of populations and of individual plants, is needed to understand the interactions between prairie fringed orchids and their environment and to help guide management of this state endangered species.

INTRODUCTION

Monitoring of rare plants has become an important stewardship activity within the last decade as attention has been focused on the status, management needs, and recovery planning for state and federal listed species (Palmer 1987). Although annual census counts lack the precision of demographic techniques, they can gauge short-term and long-term population fluctuations, especially in relation to changing environmental conditions. Here, we summarize 12 years of census data for Illinois populations of the state endangered (Illinois Endangered Species Protection Board 1990) and federal threatened (U.S. Fish and Wildlife Service 1989) eastern prairie fringed orchid (*Platanthera leucophaea*). The 1990-91 data were gatherered in conjunction with fieldwork for the preparation of the federal recovery plan for this species, which provides range-wide recovery guidelines based on population and habitat status and management needs.

A primary objective of recovery planning was to catalog extant populations of *Platanthera leucophaea*, project their likelihood for long-term survival, and provide recommendations for increasing the viability of populations. We provide this information for Illinois populations and examine the relationship between precipitation, hydrology, and flowering over time in Illinois. The appearance of flowering

prairie fringed orchids is erratic, and reportedly related to precipitation, fire frequency, site hydrology, and plant community successional stage (Sheviak 1974, Bowles 1983). We therefore sought to determine if wetland sites consistently have more flowering plants than upland sites, and if growing season precipitation levels correlate over time with fluctuating numbers of flowering plants.

BACKGROUND

Distribution and status

Platanthera leucophaea and its western species pair *P. praeclara* are characteristic orchids of the tallgrass prairie region of eastern North America (Sheviak and Bowles 1986). *Platanthera leucophaea* ranged from the immediate Mississippi River drainage eastward across the Wisconsinan till plain in a narrowing pattern corresponding to the prairie peninsula of Transeau (1935). Disjunct populations occurred farther north and east in southern Canada, Maine, New Jersey, and Virginia wetland habitats (the species' range is mapped in Bowles 1983 and Sheviak and Bowles 1986). Illinois probably supported larger and more extensive presettlement populations of this orchid than any other state. Originally the species was known from tallgrass prairie in 33 counties across the northern two-thirds of the state, an area now almost completely converted to agriculture (Sheviak 1974, Bowles and Kurz 1981). Twenty-one prairie fringed orchid populations now remain in eight Illinois counties, a 75% decline in extant county records based on voucher specimens (Figure 1). The overall decline of numbers of plants in Illinois since settlement, however, probably reflects the loss of prairie habitat, of which less than .007% remains (White 1978).

Life history and ecology

When flowering, *Platanthera leucophaea* is one of the showiest prairie plants. Inflorescences of 30 or more fragrant white flowers usually overtop the prairie canopy, and pollination is by nocturnal hawkmoths (Family Sphingidae) as they ingest nectar from the flowers' long nectar spurs. Terrestrial orchids are well known for periodic dormancy, apparently during unfavorable conditions or environmental uncertainty (Calvo 1990). The irregular flowering of *P. leucophaea* may result from avoidance of drought stress or impact from grazing in its grassland habitat (Bowles 1983). Often many plants in *P. leucophaea* populations are vegetative (*i.e.*, without flowers), and some may be entirely dormant in an undergroud state. During periods of reduced growth or dormancy, especially during environmental stress, the plants may be supported by mycorrhizal nutrition. Plants develop flowering primordia during the growing season prior to flowering, thus dormancy or reduced vigor one year can have a carry-over effect on numbers of flowering plants in subsequent years. The orchid mycorrhizal relationship begins with seed germination, allowing the development of a chlorophyll-free protocorm that requires fungal nutrition for several years until a vegetative stage is reached; mycorrhizae are apparently maintained throughout the plant's life (Stoutamire 1974, Sanford 1974).

The eastern prairie fringed orchid requires full sunlight for optimum growth and flowering. Throughout much of its range, it inhabits mesic to wet circumneutral to calcareous tallgrass prairies (Sheviak 1974, Bowles 1983). Most extant Illinois populations occur in soils derived from loess deposits over glacial till or outwash, which characterize the Grand Prairie Natural Division of Illinois (Schwegman *et al.* 1973). In these habitats, populations occupy a continuum extending from mesic upland prairie to wet prairie along the borders of prairie potholes and watercourses. Plants in upland habitats appear to flower infrequently, probably only during seasons of relatively high precipitation. Secondary habitats include sand deposits of the Lake Michigan lake plain and sedge meadows, which are essentially restricted to the Northeastern Morainal Natural Division of Illinois (Schwegman *et al.* 1973).

Under stable conditions, *Platanthera leucophaea* appears to be long-lived. Case (1987) reported that plants survived and produced seeds for up to 30 years in a garden, and several extant Illinois populations survived for decades in cemetery prairies under mowing regimes that probably prevented reproduction by removing inflorescences or seed capsules. However, high population densities can occur in early- to mid-successional habitats compared to late-successional habitats (Bowles 1983). As these communities undergo succession, populations may decline and disappear. Prairie

fringed orchids have been introduced from seed into formerly grazed successional prairie habitat in the Chicago region (Packard 1991), with flowering plants appearing five years after seed dispersal.

METHODS

Population and environmental data

In 1980, the senior author began to census annually flowering plant numbers in Illinois populations of *P. leucophaea*; more recently, populations also have been censused by volunteers coordinated through The Nature Conservancy. These census data were compiled for 1980-1990; all known Illinois *Platanthera leucophaea* localities were revisited during July 1991 and examined for successional changes since previous visits, along with other management needs. Locations of plant populations that had been previously mapped or marked, along with other potential habitats, were searched for flowering plants.

For comparing effects of hydrology on flowering, sites were divided into three classes along a **mesic** (n = 4 sites), **wet-mesic** (n = 5 sites), and **wet** (n = 3 sites) hydrological gradient. These sites were differentiated by field inspection according to their topographic position and characteristic vegetation types (*sensu* White 1978). The proportions of years with or without flowering populations were compared between mesic, wet-mesic, and wetland habitats by goodness of fit tests. The monthly precipitation for April-July of each year and their deviations from the 30-year norm were obtained from National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center monthly summary reports for northeastern Illinois, where most of the orchid populations occur. April-July rainfall was chosen because it represents the period during which soil moisture levels might effect emergence and growth of *Platanthera leucophaea*. As this orchid flowers by late June or early July, July precipitation would be more critical for perennating bud development and flowering during the subsequent season. Sequential nonrandomness in precipitation was tested for with the mean squared successive difference (MSSD) test (Ghent 1971). A Kendall rank correlation test was used to test for a significant relationship between total annual census numbers and departures of April-July rainfall from the 30-year norm. For this test, July rainfall was omitted from the 1991 data set, as it would not affect flowering during 1991.

Demographic data were collected from the largest Illinois population (~200 plants), which occurs in wetland habitat. Since 1985, flowering plants in this population have been permanently marked and their fates subsequently monitored. Only during the 1988 drought, when no flowering plants appeared, were the conditions of previously marked plants not monitored. Because unmarked vegetative orchids cannot easily be found, initial cohort data included primarily flowering plants. Development of a more precise assessment of population structure, including flowering, vegetative, and dormant states, will require long-term monitoring and differentiation between dormancy and mortality.

Estimating population viability

For the federal recovery plan, the likelihood of long-term survival was estimated by developing an **Artificial Viability Index** (**AVI**). The index is calculated from the formula **AVI** = $[\Sigma_{i\text{-}n}\ A_i + B_i + C_i + D_i + E_i]/15$. A-E represent population size, habitat size, degree of disturbance, protection status, and management needs, respectively. Appendix I presents the criteria for establishing the values for each variable. A and D range from 0-3; B,C, and E range from 1-3. Dividing by 15 adjusts the index range from 0.2-1.0. **Low AVI** values are <0.5, **moderate AVI** values range from 0.5-0.75, and **high AVI** values are 0.75-1.0. In most cases, management, protection, or restoration measures can be used to increase the value of each variable, and thus the **AVI**.

RESULTS

Hydrology and precipitation: effects on flowering

Site hydrology as interpreted by topographic position had a significant effect on flowering; wet sites had proportionally more (X^2=21.4, P<.001) years with flowering plants than either mesic or wet-mesic sites. Flowering plants were present 89% of the time in wet sites, but less than 40% of the time in both mesic and wet-mesic sites (Figure 2).

April-July precipitation appeared to an important factor affecting flowering plant census numbers

between 1980 and 1991 (Figure 3). Precipitation was nonrandom and cyclic over time ($Z = 5.73$, $P<.0001$). High levels occurred in 1981-1983 and in 1990, intermediate levels occurred in 1980, 1984, 1987, and 1991, and low levels occurred in 1985-1986 and 1988-1989. The most severe growing-season drought in 50 years occurred in 1988. Flowering among orchid populations followed a similar pattern, with total census numbers ranging from 4 in 1988 to 313 in 1987 (Figure 3). There was an overall significant ($P = .0397$) Kendall rank correlation test between annual orchid census numbers and departures from mean rainfall. Census numbers were lowest in years corresponding to low precipitation, which suggests that low precipitation levels had immediate effects on flowering. This was most evident during the 1988 drought, which apparently affected the numbers of flowering plants for three years, even though precipitation was high during 1990. Less severely dry years appeared to affect the numbers of flowering plants in those years only, without the impact carrying over into subsequent years. For example, the highest annual census occurred in 1987, a year of moderate rainfall following two consecutive years in which precipitation and numbers of flowering plants were low, but not as severely low as in 1988.

Demographic monitoring revealed an unexpectedly high turnover of flowering plants in the Lake County wetland site (Figure 4). In 1987, there were over 100 flowering plants. The 1988 drought reduced flowering plants to near zero for two years, apparently forcing many into dormancy or vegetative condition. For example, 49 (33%) of the 148 plants found between 1985 and 1987 were relocated in 1989, but only two were flowering. In 1990, 40 (27%) of the 148 plants reappeared, but only four were flowering. Only four new plants were found in 1989, and 32 previously unmarked plants were found in 1990; 32 (88.9%) were flowering. Because flowering plants require about 5 years to appear from seed, these plants apparently had also survived the drought. In 1991, after six years of monitoring, only 30 (16%) of 184 marked plants were found to re-flower, while 100 (54.4%) were not found at all, and were either dormant or had died. Eighty-nine new plants were found in 1991; 70 (78.6%) were flowering, and had also apparently survived the 1988 drought.

<u>Population status and viability</u>

Twenty-one *Platanthera leucophaea* populations are now probably extant in Illinois. Nineteen of these populations occur in six Chicago-region counties, including two Cook County sites at which plants have been restored; single *P. leucophaea* populations occur in cemetery prairies in eastern and west-central Illinois counties. We considered populations in DuPage County and at Illinois Beach State Park as extant, although plants were not observed at either site in 1991 (Note: In order to protect orchid populations, site names will be provided only for Illinois Beach, where plants cannot be located without specific information). Plants were observed in the early 1980's at the DuPage County station, but altered site hydrology may have destroyed or severely reduced this population. Plants were observed at Illinois Beach as early as 1908 (Gates 1912), and have been reported as recently as the late 1970's. This population may now be very small or even ephemeral. A large population that occurs one mile north of Illinois Beach (in Wisconsin) could serve as a seed source for dispersal and periodic recolonization in Illinois. Excluding two sites on the Chicago Lake Plain, and three sites in sedge meadow, all Illinois populations occur in loess soils over glacial drift.

Only one Illinois population, in Lake County, ranks as highly viable (Figure 5). This station is in county ownership, and in part a state nature preserve. It contains a diversity of prairie habitats ranging from mesic to wet, and supports the largest and most extensive Illinois population of prairie fringed orchids. Ten Illinois sites rank moderate viability. One of these sites, also in Lake County, supports a population size similar to that of the highly viable site, but the habitat is smaller and contains only mesic conditions, and orchids appear less frequently. Illinois Beach was ranked moderately viable because of its extensive habitat and legal protection, although the orchid population status is unknown. Only three populations occur in habitats supporting communities ranked as grade "A" by the Illinois Natural Areas Inventory. These sites ranked moderately viable because they are legally protected, but small in size and in population numbers.

Other populations ranked moderate to low viability because of small population and habitat size, early

successional stage, nonbinding protection, or management problems (Figure 6). Small population size was the most frequent problem, with only two of these sites supporting more than 50 plants. Population sizes can only be estimated, and in most of the moderate to low viability sites, especially smaller sites that do not include wetland habitat, far fewer than 50 plants were found. Thirteen of the Illinois populations, all of which are in the Chicago region, occur in formerly disturbed habitats. The long-term stability of these populations is unknown because of their potential to decline with successional change (see discussion). Only six of the Illinois populations, having less than 20% of the Illinois plants, occur on dedicated nature preserves. Most of the Illinois plants are concentrated on two unpreserved Lake County sites; the dedication of these sites as Illinois nature preserves would result in the protection of over 75% of all Illinois plants.

Management problems are the most serious threat to the long-term persistence of orchid populations. Many Illinois prairie or wetland remnants that support orchid populations are threatened by woody invasion fostered by fire suppression (Bowles 1983). Ongoing management, primarily prescribed burning, is needed to maintain all orchid habitats. Invasions by the exotic species purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus frangula*), and teasel *(Dipsacus laciniatus)* pose serious threats to orchid habitats in both Illinois and adjacent Wisconsin (Reinartz *et al.* 1987, Reinartz and Kline 1988, Solecki 1989, Bowles 1991). Although many habitats do not yet have purple loosestrife, its threat to all wetland communities is severe. Buckthorn invasion is also serious. Prescribed burning alone will not control these species; cutting, herbiciding, and pulling are also necessary.

DISCUSSION

Precipitation, hydrology, and flowering

Precipitation during the growing season appears to have a strong effect on the flowering and structure of *Platanthera leucophaea* populations. A severe drought affected even a wetland population, reducing flowering plant numbers to near zero for three successive years. However, some plants survived, and some flowered within two years. The effect of drought is apparently even more significant in upland habitat. Schwegman (1992) could not relocate two marked plants in an upland mesic site after the drought of 1988. A colony of 27 plants surveyed at the same site in 1982 has not reappeared after two drought cycles and, although other orchids occasionally appear at the site, this colony is presumably lost (M. Bowles and R. Nyboer, unpublished data). Because precipitation is stochastic, and the proportions of flowering, reflowering, vegetative, and dormant individuals depend on past climatic conditions and levels of reproduction, orchid populations may be in perpetual disequilibria.

Because drought years can limit flowering and reproduction, especially in drier sites, they can affect future population demography, and possibly cause local population extinction in homogeneous landscapes. If upland populations that decline or go extinct during droughts are adjacent to lowland populations that can survive droughts, the upland sites have a greater likelihood of being recolonized. Although long-term census data cannot explain the demography of such population dynamics, it can track population fluctuations in relation to precipitation cycles.

Orchid populations: management uncertainty in successional communities

Sheviak (1983) suggested that *Platanthera leucophaea* was extremely rare in the Chicago region, having not exploited prairie remnants in this area's low degree of agricultural activity. However, by the early 1980's, almost twenty populations had been discovered in a range of successional conditions, suggesting a dynamic state of colonization. Most populations are in prairie or wetlands that have been degraded by past overgrazing; orchids may have colonized these sites following grazing, or in some cases may have survived and spread after grazing.

The successional status of these populations presents a paradox and management challenge. As with many orchid species, prairie fringed orchids occur more frequently and with higher densities in successional communities, where they often decline as succession proceeds (Bowles 1983, Case 1987, Sheviak 1990). Although management for orchid species with early-successional conditions may maintain higher orchid

numbers (Sheviak 1990), prairie management is most feasible and cost effective when it directs succession toward stable late-successional conditions, using prescribed burning to maintain climax species equilibria. The persistence of low-density orchid populations in late-successional presettlement prairie would have been facilitated by orchid longevity, the constancy and long-distance flights of hawkmoth pollinators, wind-dispersed seeds, and colonization of stochastic patch disturbances.

Small preserves often cannot maintain landscape disturbance regimes (Noss 1987) or populations of habitat-size-restricted vertebrates that may create regeneration niches (*sensu* Platt 1975). As a result, on smaller preserves artificial management may be needed to create regeneration niches for low-density plant species such as orchids. Where possible, land acquisition and community restoration should be used to build units that are large enough to support endogenous disturbances and that are more likey to be exposed to exogenous disturbances.

CONCLUSIONS

Although eastern prairie fringed orchid population dynamics may be complex, a strong correlation appears to exist between cyclic precipitation and the appearance of flowering plants. Likely, extreme drought suppresses flowering by inducing dormancy, and this effect carries over into subsequent years. However, long-term demographic monitoring and experimentation is needed to interpret the reactions of individual plants, and the effects of site hydrology, heterogeneity, and management on population viability. Two other factors, fire and reproduction, may also affect the appearance of flowering plants and were not assessed in this study. It is likely that prescribed burning enhances the appearance of flowering plants (Sheviak 1974, Bowles 1983); however, the effect may occur during years of intermediate to high precipitation, but not during drought years. Reproduction is known to have a carry-over effect on some orchids, with the cost of heavy fruit-set limiting plant vigor in subsequent years (*e.g.* Snow and Whigham 1989, but see Case 1987). As a result, heavy flowering and seed production in *Platanthera leucophaea* could interact with rainfall cycles and burning, either further reducing flowering in drought years, or damping flowering during years of high rainfall and prescribed burns.

Assessment of habitat viability through an artificial viability index (AVI) may be useful in guiding the preservation and management of orchid populations, and in selecting sites that represent the diversity of communities and habitats used by *Platanthera leucophaea* in Illinois.

Managing for the persistence of *Platanthera leucophaea* may be complex. Only a few Illinois populations now exist on essentially undisturbed prairie habitats, and these small populations may decline with attrition. Many Illinois populations occur at higher densities in early-successional communities, but populations in these habitats may also decline with advancing succession. This presents a management paradox for *P. leucophaea*. Prairies are usually managed for succession toward stable climax conditions, but disturbance and successional conditions seem best to promote high orchid densities. In addition, small preserves do not afford landscape disturbance processes. These dilemmas may be best resolved by managing for regeneration niches in small preserves, or increasing preserve sizes.

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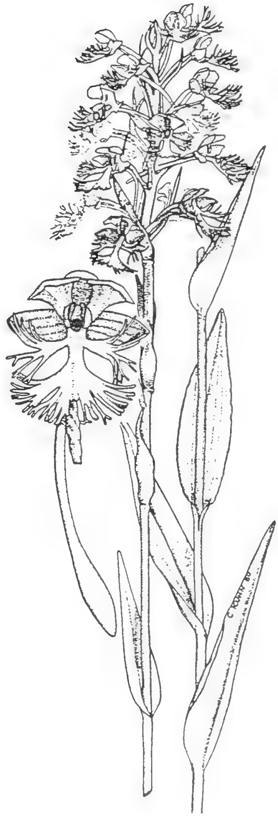

Platanthera leucophaea (Nutt.) Lindl.
Illustration reproduced by permission from R.S. Mitchell and C.J. Sheviak. 1981. *Rare plants of New York State.* Bulletin No. 445 of the New York State Museum.

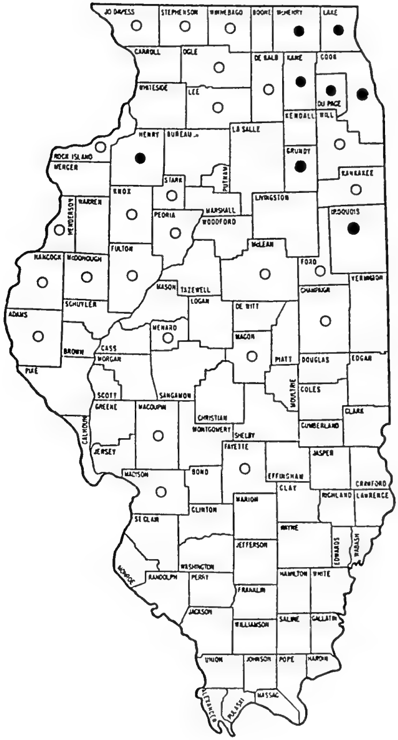

Figure 1. Illinois distribution of *Platanthera leucophaea* by counties. Closed circles indicate one or more extant populations. Open circles indicate historic records for which populations can no longer be found.

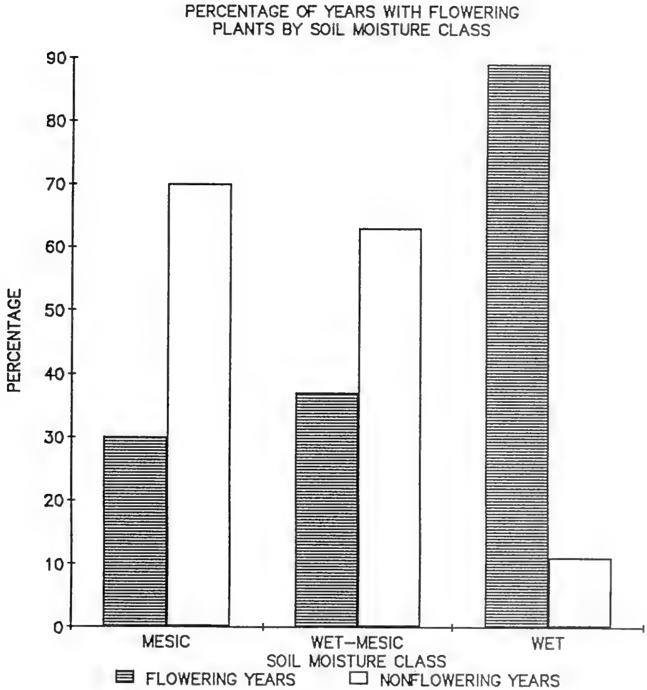

Figure 2. Percentage of years between 1980-1991 in which flowering *Platanthera leucophaea* populations were censused in **mesic** (n = 4 sites), **wet-mesic** (n = 5 sites), and **wet** (n = 3 sites) habitats. See text for habitat classification methods.

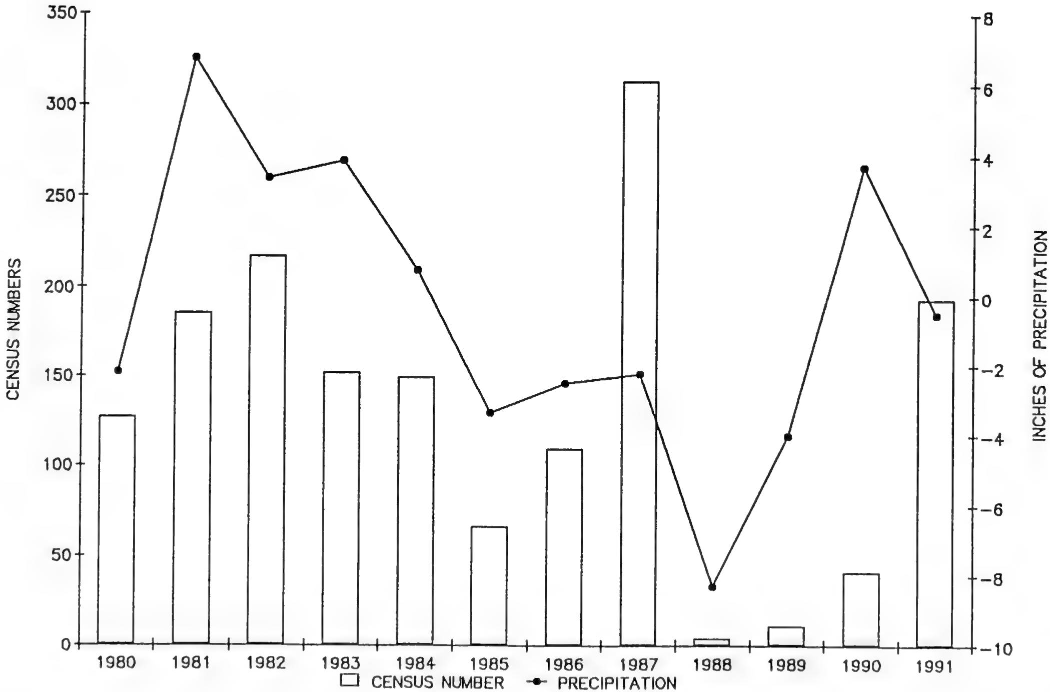

Figure 3. Relationship between precipitation and flowering among 19 *Platanthera leucophaea* populations over time. Inches of rainfall represent the April-July annual departure from the 30-year norm established by the National Oceanic and Atmospheric Administration.

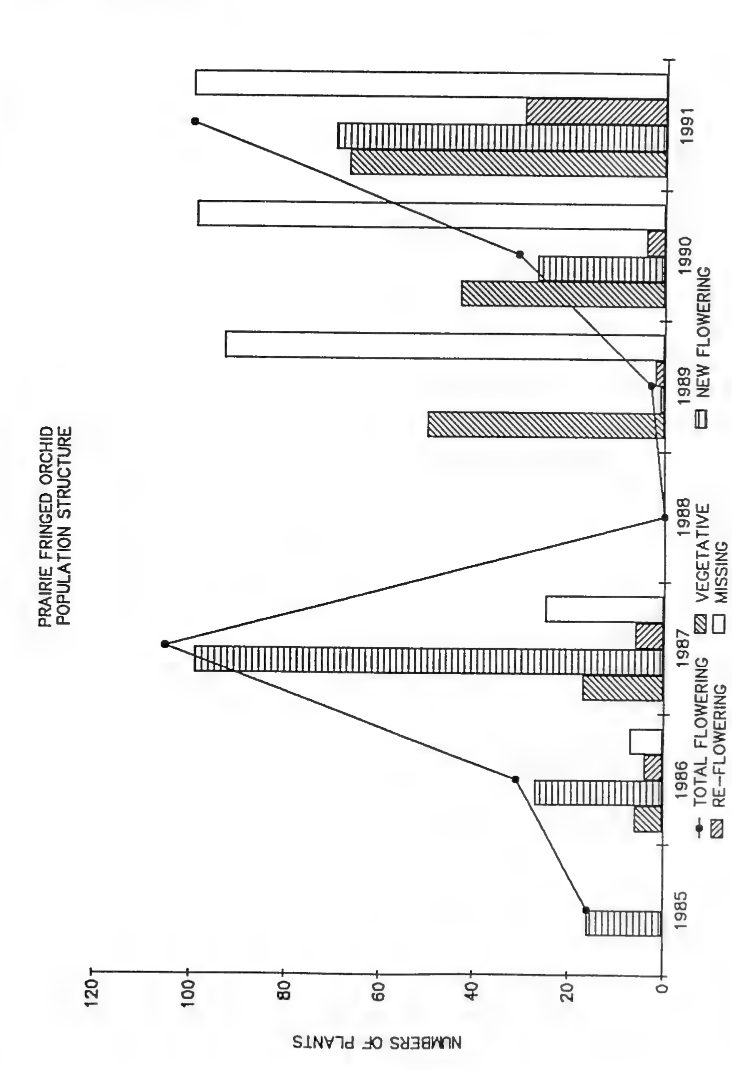

Figure 4. Comparisons of *Platanthera leucophaea* population structures before and after severe drought. Only flowering plants were monitored in 1988. Data collected from wetland habitat in Lake Co., IL.

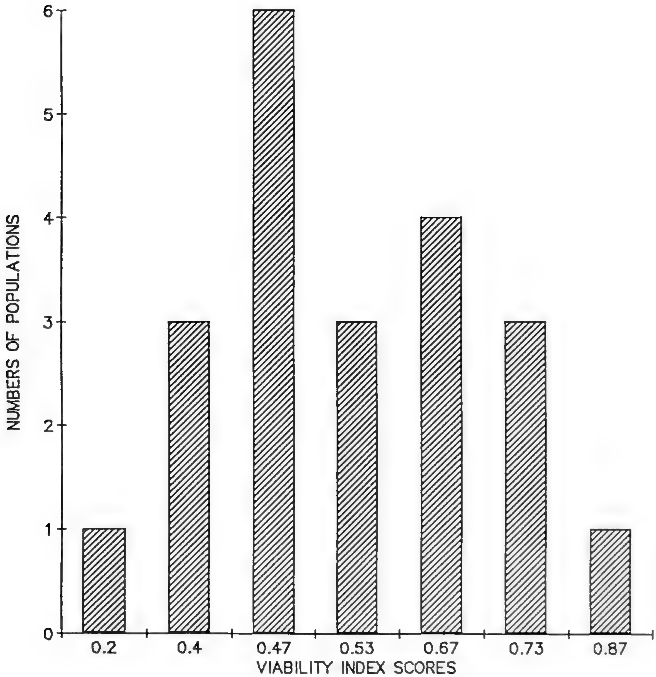

Figure 5. Distribution of 21 Illinois *Platanthera leucophaea* populations in relation to their Artificial Viability Index (**AVI**) scores. Low **AVI** values are <0.5, **moderate AVI** values range from >0.5-0.75, and **high AVI** values are >0.75-1.0. See text for calculation of index scores.

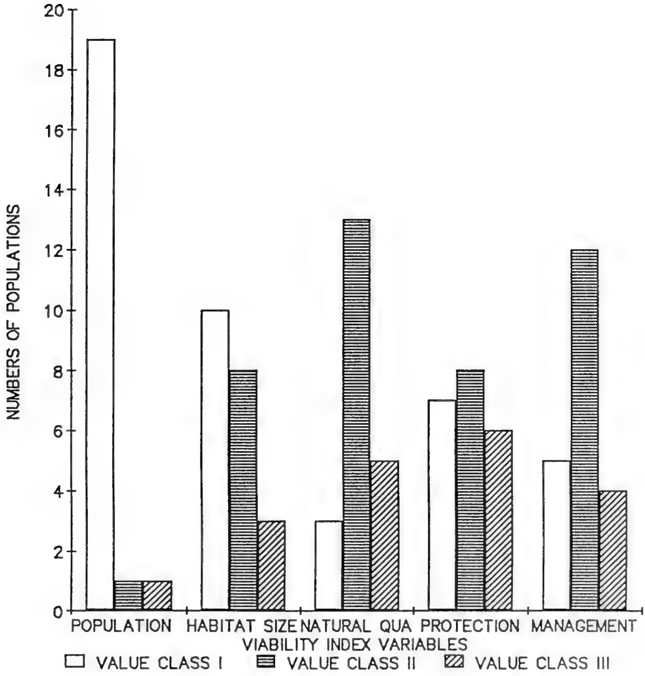

Figure 6. Distribution of 21 Illinois *Platanthera leucophaea* populations in relation to the five variables used to calculate Artificial Viability Index (AVI) scores. See Appendix I for methods used to quantify each value class.

Appendix I. Determination of Artificial Viability Index (AVI). AVI = $[\Sigma_{i\text{-}j} A_i + B_i + C_i + D_i + E_i]/15$. AVI ranges from 0.2-1.0, and is arbitrarily divided into three groups. Low viability = <0.5; moderate viability = >0.5-0.75; high viability = >0.75-1.0.

		VALUE	
Variable	(0[1]-1[4])	(2)	(3)
A. Population size[1]	small <50 plants	medium >50-100 plants	large >100 plants
B. Habitat size[2]	small <2 hectares (<5 acres)	medium >2-20 hectares (>5-50 acres)	large >20 hectares (>50 acres)
C. Degree of past disturbance/successional stage of natural community[3]	heavy/early-successional	moderate/mid-successional	light/late successional
D. Protection/status[4]	none/informal	formal	legal
E. Management needs[5]	severe	moderate	low

[1]Based on recent census data and current habitat conditions. These data represent flowering plants only, and may represent <100% of total populations. Values of 0 are given to small populations that appear in jeopardy or have not been relocated.

[2]Habitat size takes into account only those areas of the site that support, or have the potential to support, prairie fringed orchid populations.

[3]Assumes that populations may not be maintained at existing levels as succession advances from recently or severely disturbed to late-successional plant communities.

[4]None = private ownership with no protection (value = 0); informal = private ownership, without legally binding protection; formal = private or public ownership with formal but not legal protection; legal = private or public ownership with legally binding protection.

[5]Includes threats such as exotic species invasion (*e.g.* glossy buckthorn and purple loosestrife), surrounding land use (*e.g.* drainage, development, pollution), development threats (on private tracts), and fire protection/brush invasion.

Technical Comments on the Proposed Revisions to the 1989 Wetland Delineation Manual[1]

Gerould Wilhelm

The Morton Arboretum
Lisle, Illinois, 60532

On 10 January 1989, the U.S. Environmental Protection Agency, U. S. Army Corps of Engineers, Department of Agriculture Soil Conservation Service, and Department of Interior Fish & Wildlife Service adopted an interagency document entitled "Federal Manual for Identifying and Delineating Jurisdictional Wetlands." It provided guidance for identifying and delineating wetlands for various purposes, most particularly for determining wetlands under the jurisdiction of the Clean Water Act, Section 404 regulatory program. On 14 August 1991, this same interagency consortium proposed a revision to the 1989 manual [Federal Register 56(157):40446-40480]. At that time, there was a request for public comments on the proposal, which comments were to have been submitted by 15 October 1991.

The 1989 manual was quite detailed, and with the exceptions discussed below, its use generally enabled an accurate delineation of wetland. The 1991 proposed revision continues to rely on the determination of the presence of hydric soils, hydrophytic vegetation, and evidence of hydrology as essential parameters. Page 40446 presents the following goal: *Of paramount importance . . . is to maintain and improve the scientific validity of our delineation methods.* Immediately following this stated goal six concerns having to do with the 1989 manual are listed. These concerns essentially imply that the application of the 1989 manual delineates too much wetland. The revision proposes to make the visible manifestation of hydrology requisite during the drier months of the year, a restriction which essentially limits the term "wetland" to permanent water bodies. It is my opinion that such a reliance on hydrology is not a scientifically valid approach to wetland definition. Certainly, hydrology is a *driving force* in wetland development, but when water is no longer present, proof of the length of its tenancy becomes problematic. While there were technical, scientifically-based problems with the 1989 manual, they are not addressed adequately in the proposed revision. These problems persist, with the added problem of the impracticality of having to prove hydrology during the growing season.

As in the 1989 manual, vegetational analysis still relies appropriately on the National Wetland Categories for species, as described by Reed (1988), where plants are categorized as obligate wetland inhabitants, upland inhabitants, or facultative to either side of the hydrological gradient. Some fundamental misconceptions are carried over from the 1989 manual regarding community classification, species dominance, and the inclusion of non-native species in the delineation calculations.

Another problem with the 1989 manual, made much worse by the proposed revision, is the attempt to find a single definition of a wetland that encompasses the estuaries of southern Florida and those in the prairies of Illinois. One reason the National Wetland Categories (Reed, 1988) are valid wetland indicators, when applied appropriately, is the division of the United States into physiographic regions with each species being evaluated on its autecology in each region. A similar strategy should be explored for wetland definition. Indeed, while the proposed revision accepts the valid notion that in various biomes individual species vary in their likeliness to grow in wetlands, it seems illogical to

[1]This paper is an edited and revised rendering of a letter which the author submitted to Gregory Peck, U.S.E.P.A., Washington, DC, in response to a request for public comments on the proposed revisions to the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands.

assume that a wetland definition would not be more accurate if it were more specific to each region.

Neither the 1989 manual nor the proposed revision addresses another important aspect of wetland identification: wetland mitigability. The structure and function of some wetlands are easily replicated using current expertise and technology, while others are of such complex synecological character that routine mitigations are unable to reproduce their viability. An assessment of the degree of mitigability regarding a target wetland should be made at the time of delineation in order to aid regulators in determining terms of permit approval. If such assessments were made, many permits could be handled quickly and expeditiously, while in other cases the applicant would know immediately that permit approval could be problematic.

HYDROLOGY

Evidence of the occupancy of water on a site is important, but the duration or amplitude of occupancy is difficult to determine when water is absent. One of the guidelines in the proposed revision governing the measurement of wetland hydrology states that soil saturation must persist *for 21 or more consecutive days during the growing season* or sustain *inundation for 15 or more consecutive days.* Growing season and indicators of wetland hydrology are both problematic criteria.

Growing Season. As defined in the proposed revision, the growing season is . . . *the interval between 3 weeks before the average date of the last killing frost in the spring to 3 weeks after the average killing frost in the fall.* Growing season is defined arbitrarily by a parameter based upon the average frost-free days, with a 3-week extension period at each end. In the central Great Lakes Region, the attempt to define a wetland as having a fundamental relationship to the "growing season" is untenable. If the logic of the proposed revision is followed, soil hydration outside the growing season is considered irrelevant.

Since the point of wetland delineation is to identify correctly those areas which receive standing water or chronic soil hydration, criteria should be designed which are helpful toward that end. The proposed revision attempts to establish criteria, which when adhered to, are inconsistent with accurate wetland delineation. Wetlands are characterized not by annual crop plants but by plants native to a region. Therefore, attentiveness to growth and maturation patterns of the native plants in a given region is informative with regard to growing season definitions. The growing season as it is defined by the proposed revision is about 2 months shorter than is expressed in nature.

According to the National Climatic Data Center, from 1951-1980, in the Chicago region, there was a 50% probability that a late spring freeze would occur after 3 May and that an early fall freeze would occur before 10 October. May 3rd is in the 18th week of the year, so the beginning of the growing season as defined by the proposed revision would occur 12 April, the 15th week. October 10th is in the 40th week of the year, so the end of the growing season would fall in the 43rd week. According to the criterion in the proposed revision, the Chicago region's growing season is 28 weeks in duration. This parameter does not encompass the growing season of native flowering plant species.

In the Chicago region, there are 1570 native vascular plants (Swink & Wilhelm, 1979).[2] Flowering periods of 1252 of these, including grasses and sedges, have been documented. It has been recorded over the past decades, for example, that *Actaea pachypoda* (White Baneberry) has been in anthesis during the period 30 April to 4 June. In the case of most species, these dates are the extremes of flowering and were not recorded in the same year. Presumably, in any given year, any plant species is likely to be in bloom near the midpoint of its phenological range. In the case of *A. pachypoda*, the early date falls in the 17th week of the year and the late date in the 22nd week. The midpoint in the flowering period of *A. pachypoda* is week 19.5 or 13 May.

Fifteen Chicago region species have their midpoint blooming ranges in the 5 weeks prior to the beginning of the growing season as defined by the proposed revision, the earliest blooming midpoint falling in week 10 (8-14 March). It stands to reason that spring growth begins normally at least a week earlier, week 9 (1-7 March). None of the species of the Chicago region have midpoint blooming ranges after the 43rd week, but nine have midpoint ranges

[2]The Chicago region, as defined by Swink & Wilhelm (1979) includes 3 counties in southeastern Wisconsin, 11 in northeastern Illinois, 7 in northwestern Indiana, and 1 in southwestern Michigan.

after the 40th week. Since these species must then have time to mature fruit, an additional 2 or 3 weeks of nutrient movement is necessary. The practical end of the growing season then falls during week 45, 2 weeks after the end of the growing season as defined by the proposed revision.

When the 6 additional weeks of spring are added to the 2 additional weeks of fall, the documented growing season of native vascular plants in the Chicago region is 8 weeks longer than that defined for this region by the proposed revision. The actual growing season begins with the 9th week and ends during the 45th week in our region. Clearly, the 3-week criterion used in the proposed revision has no scientific basis in defining either the beginning or the end of the growing season in this region.

Also, the new manual would presume that soil inundation or saturation is not important prior to or after the growing season or that the effects do not differ materially from soils in unsaturated lands. However defined, the criterion in the proposed revision is that, in order to meet the definition of wetland, an area must be . . . *inundated for 15 or more consecutive days, or saturated from surface water or from ground water to the surface for 21 or more consecutive days during the growing season.*

In the Chicago region, as in much of the prairie biome, microbial activity is evident in anaerobic respiration that can occur any time during the year when the ground is unfrozen. Since the whole point of wetland delineation is to identify wetlands, land areas where water accumulates, arbitrary parameters such as growing season circumscription are superfluous. Even if the growing season were more rationally defined, there would be no scientific basis in ignoring the effects of anaerobic activity and nutrient movement on soil morphology during the dormant months.

Wetland Hydrology Indicators: On page 40452 of the proposed revision, four wetland hydrology indicators are listed, only one of which must be present. While this appears to be an expansive suite of options, in practice it is cumbersome and contradictory, and application can give counterintuitive results. Numbers 1 and 2 are not real options.

Number 1: A minimum of 3 years of hydrologic records collected during years of normal rainfall and correlated with long-term hydrologic records for the specific geographical area that demonstrates the area meets the wetland hydrology criterion. Three years of hard hydrologic data almost never exist in the Chicago region, and no developer I have ever worked with would be willing to finance such a study or defer his development plans that long. In practice, it is a wholly impracticable option, though if such a data set were to exist already for a site it would be unwise to ignore it.

Number 2: Examination of aerial photography for a minimum of 5 years [which] reveals evidence of inundation and/or saturation in most years [3 of 5, 6 of 10] and correlated with long-term hydrologic records for the specific geographical areas demonstrate that the area meets the wetland hydrology criterion. In those instances where photographs show such standing water, it is impossible to tell when it got there and how long it will remain at any given topographic level. Rain gauge data on midwestern thunderstorms from Wheaton, Illinois or O'Hare Airport in Chicago are useless in determining actual rainfall patterns even in nearby areas. So correlations are impossible. Again, in practice, this is a wholly impracticable option, though if such data were to exist already for a site it would make sense to utilize it.

Number 3: One or more primary hydrologic indicators, which when considered with evidence of frequency and duration of rainfall or other hydrologic conditions, provide evidence sufficient to establish that an area is inundated for 15 or more consecutive days or saturated from surface water or from groundwater to the surface for 21 or more consecutive days during the growing season in most years, are materially present.

- a. *Surface water inundation.*
- b. *Observed free water at the surface in an unlined bore hole.*
- c. *Water can be squeezed or shaken from a soil sample taken at the soil surface.*
- d. *Oxidized stains along the channels of living roots.*
- e. *Sulfidic material within 12 inches of the soil surface.*

f. *Specific plant morphological adaptation/responses to prolonged inundation or saturation: pneumatophores, prop roots, hypertrophied lenticels, a[e]renchymous tissues, and floating stems and leaves of floating-leaved plants growing in the area, and buttressed trunks or stems.*

With respect to items "a-c," I have never had the opportunity during a routine wetland determination to spend the time to defer delineation so that I could actually observe that portion of the wetland border which remained under water for 15 days or saturated for 21 even in one year, much less "most years." During a wetland delineation attempt at the West Chicago Prairie in September, 1991, on a morainic region west of Chicago, evidence of items "d-f" were searched for in well-documented, undisturbed wet prairie and sedge meadow plant communities; none could be found. There is no scientific basis for expecting these features to be present in such communities.

*Number 4: If none of the indicators in items 1, 2, or 3 is [*sic*] present, one or more of the following secondary hydrologic indicators should be used in conjunction with corroborative information that supports a wetland hydrology determination. These secondary indicators may only be used in conjunction with other corroborative information that indicates wetland hydrology.*

a. *Silt marks that indicate inundation.*
b. *Drift lines.*
c. *Surface-scoured areas.*
d. *Other common plant morphological adaptations/responses to hydrology; shallow root systems and adventitious roots.*

In undisturbed midwestern prairie wetlands and minerotrophic fens and sedge meadows, items "a-c" are not likely to be seen. Such wetlands are prevailingly ombrotrophic or minerotrophic, so evidence of surface flows laden with sediments are irrelevant factors. Occasionally evidence from item "d" can be present, but by no means routinely.

The attempts to define wetlands uniformly across physiographic provinces and to keep hydrology as a discrete criterion lead naturally to absurd conclusions. In practice, the proposed revision excludes most natural wetlands of the Prairie Biome from wetland status. The fact that this region receives 80-100 cm of precipitation per year over every square centimeter suggests that water must go somewhere. Actually, the two features which do corroborate hydrology in the Midwest, soils and vegetation, have been singularly excluded from consideration. Soils and vegetation resident on a site have a chemical and genetic imprint which transcends our ability to think up all the ways of discerning a pattern of hydrology.

VEGETATION

One of the most serious problems with the 1989 manual, and which persists in the proposed revision, is the inclusion of weed (non-native) species in the vegetational analyses. Another is an attempt to define "dominant species." The requirement to discriminate wetland plant communities does not lead to spurious results, necessarily, but it is irrelevant in determining wetland borders. The only relevant information in delineation is that which discriminates the wetland from the upland, the area which delineates the jurisdictional wetland.

The analytical protocol described by the manual, which is far too involved to recapitulate or summarize here, does not do well in defining the wetland border. Trying to identify plant communities by the method described is essentially subjective, since the plant communities are chosen in an entitative process, then described by a transect. There are well-known ordination techniques which can define plant communities, if that is the goal. Following the wetland manual, even if the plant community is chosen well, the data treatment tends to average any variation in it, and still the wetland border remains unaddressed. For all that, the method is unnecessarily complicated and can be far too time-consuming in diverse wetlands, and assessments are overly influenced by "dominant" species. A much simpler, more reliable, alternative

is presented below as the various issues are explored.

Native *versus* Adventive Species: With the exception of a couple hundred rare waifs and scarcely spontaneous exotics, there are 2083 species of vascular plants which comprise the spontaneous flora of the Chicago region. Of these, 513 (25%) are known to be weeds (adventives) from Eurasia or from districts remote from the Chicago region. Adventive species have been in the area less than 1.5% as long as the natives, and their adaptation is to an altogether different ecological context. The presence of these adventive species informs us little about the wetness or dryness of a site. Since they are adapted primarily to the agricultural, well-drained arable soils of the Northern Hemisphere, the extent of their presence reveals more of a disturbance history and post-settlement land use. The remaining 1570 species are believed to be native to the region. The adaptability of these native species to wet or to dry ground can be regarded as a more profound indicator, inasmuch as each of these elements played a role in some presettlement plant community. Each one has been adapting to some facet of local hydrologic gradient throughout much of the Holocene.

If the goal is to determine site wetness based upon vegetation, then the use of native species as indicators is a strong measure. Table 1 shows the difference between the proportion of native and adventive species in each National Wetland Category. The more even distribution of native species among wetland plant categories reflects adaptation of native vegetation communities to gently variable hydrologic gradients typical of undulating topographies. The weed flora indicates a history primarily of disturbed, well-drained soils. An immense amount of experience locally has shown that when adventive species are incorporated into an analysis of wetness, results can be spurious.

Dominant Species: Problems also can arise when the focus is on dominant species. The problem is that dominant species have no fundamental significance as indicator plants. Not only are dominant species usually larger physically when compared to associated species and likely to be more obvious along the transect, they also tend to change with the season. Because calculation of dominance includes an estimate of basal area or cover, the results can also vary with the vicissitudes of annual climatic variation.

Small, or less easily identified, species are frequently excluded or their presence de-emphasized. *Solidago altissima*, a FACU species, can be shown to dominate disturbed wetland areas in the Chicago region in late summer, and when it does, the wetland area can appear as non-wetland. If, however, interstitial species such as *Amphicarpa bracteata* (FAC), *Bidens frondosa* (FACW), *Carex brevior* (FAC), *C. granularis* (FACW+), *C. lanuginosa* (OBL), *Geum canadense* (FAC), and *Polygonum coccineum* (OBL) are included as equal indicators, the area is shown to be populated predominantly by hydrophytic species; it is likely that the *Carex* species would have been dominant in spring. Similar confusions can work in reverse, where a mesophytic area might appear at some time to be dominated by a hydrophyte.

Each species, large or small, easily identified or not, has a long genetic memory of where it grows. Since all species grow in habitats to which they are suited, each species present in an area or in a sampling quadrat provides information equally about the wetness of the spot upon which it grows. When all *native* species identifiable in an area are analyzed together, reliable indices of wetness are obtainable.

Sampling Transect. The National Wetland Category defines the estimated probability of a species to occur in wetlands. The wetland categories included in the hydric to xeric range, *OBL* to *UPL* (see Table 1), can be expressed as 11 coefficients of species wetness, where:

$OBL = -5, FACW+ = -4, FACW = -3, \ldots FAC = 0, \ldots UPL = 5$

This is essentially the same scale as presented in the 1989 manual, but with values given to the +/- categories described by Reed (1988) as well. Values on the wet side of *FAC* are given negative numbers so that a transect, when graphed, displays wetland portions of the transect on the negative *y* axis (Figure 1).

When transects are laid out along the hydrologic gradient (catena), quadrats can be placed at regular

intervals. An inventory of the species present in a quadrat is taken, the native species discriminated, and their coefficients of species wetness summed and divided by the number of species. When these quadrat wetness coefficients of each 3 quadrats are averaged sequentially, vegetational representations of the catena are produced. Inclusion of metrics such as cover and density warps wetness values much in the same way calculations of dominance do; simple species presence gives the more accurate measure.

Figure 1 shows an example of a vegetation transect compared to topography. The transect traverses an undulating mesophytic prairie/wet prairie/sedge meadow complex. Note that the wetland border is slightly higher on the catena to the right where the slope is much gentler and probably less easily drained. The correlation between hydrophytic vegetation calculated in this way and hydric soils is remarkable only if one is surprised to discover that native plants do not grow randomly across the landscape, that they sort themselves with others into time-honored niches with disarming regularity.

When a series of transects is laid out in this fashion along the catena, the borders of the wetland can be associated with those areas of the x axis on the graph where the line intersects 0 on the y axis. The type of community is of little interest to the developer, stratum ranking is unnecessary, and complicated statistical calculations are superfluous. Neither is there a need to rely upon questionable formulations such as species dominance or to depend upon individual indicator species. Reliance upon such factors and the failure to exclude weeds can lead to frustrating results when attempting to correlate wetland plant communities with hydric soils.

It is probable that all of these factors lead the writers of the proposed revision to the spurious conclusion that there are . . . *certain difficulties in identifying wetlands from a purely botanical standpoint* . . . In fact, in almost all cases, a rational analysis of the vegetation can provide a very robust circumscription of wetland. Certainly, taken together with the soil characteristics, very accurate inferences can be made concerning the extent to which water has lain in the area.

Figure 2 shows the difference in wetland border deterimination when adventives are included in the calculations. In this case, the quadrats were at 4-meter regular intervals, so the transect shows that there was a 10-12 meter difference between the use of natives only *versus* natives with adventives. The transect was taken on a gradual slope where the soil changed from somewhat poorly drained to hydric. The point at which the native vegetation line drops below 0 is the most reliable correlative datum with the soil. A transect as described by the manual, depending perhaps on dominance assessment during a particular year or time of year, might have concluded that the site had no wetland, yet hydric soil was the prevailing substrate. There are occasions when no native species are present, and under such circumstances the mean coefficient of wetness value will be 0. Soil alone then becomes the most reliable feature; in our experience such areas usually are not wetland.

WETLAND MITIGABILITY

In connection with Section 404 of the Clean Water Act and its administration by the U.S. Army Corps of Engineers, two aspects of wetlands are emerging as important: definition and mitigability. Many wetlands in the prairie biome today consist largely of monocultures of either Reed Canary Grass or Cattails. Large tracts of moist ground and sediment-laden river bottoms have become dominated by weedy trees, under which very little else grows. The seeds of these weedy species are ubiquitous, and because they are responsive to wide tolerances in basin engineering, restoration of such wetlands often can be achieved, but their long-term diversity is very limited. Conversely, a few of our remaining wetlands are remnants of natural systems, wet prairies, sedge meadows, and fens which provide habitats for hundreds of rare native species of plants and animals. The seeds of most of these plants are not available commercially, and little is known about their propagation or autecology. Impacts on wetlands which contain significant numbers of such species are inevitable and, consequently, *irreversible and irretrievable*. It is, therefore, important to determine the extent to which impacts on individual wetlands are mitigable.

It long has been recognized that a native flora displays varying degrees of tolerance to disturbance,

as well as varying degrees of fidelity to specific habitats (Braun-Blanquet 1932). Many species, regarded as "conservative" (Wilhelm & Ladd 1988), are floristic elements which, through millennia, have become supremely adapted to niches determined by a specific set of biotic and abiotic factors. These factors include local edaphics and extremes of drought, humidity, inundation, fire, temperature, faunal interactions, *etc*. Although these factors in the aggregate have changed over time, the changes have been gradual enough and buffered sufficiently by system complexity to allow gene pools to adapt. When changes occur rapidly, as they have in the postsettlement period, both species diversity and populations of conservative species on a given tract are diminished in accordance with the severity of the changes.

Species conservatism, the degree of faithfulness a native plant displays to a specific habitat or set of environmental conditions, is the basis for the natural area assessment rationale (Wilhelm & Ladd 1988), describing a conservatism scaler spectrum of 0-10 for native species, with 0 coefficients assigned to the weediest species and 10 values assigned to very conservative species. The natural quality of an area is reflected by its richness in conservative species.

Five hundred thirty-four native species, about 34% of the native flora (322 hydrophytes) were given a coefficient of species conservatism, outside of the philosophical spectrum, of 15 or 20 for the Chicago region flora (Swink & Wilhelm 1979). Such values were given to species which the authors regarded as very rare or extirpated in the region. Typically, such species occupied plant communities which either were very rare locally to begin with or whose habitats have been very susceptible to post-settlement disturbances. A few natural wetland communities, such as bogs and fens, have high concentrations of species with values of 15 and 20.

About 11% of the native flora, including 99 hydrophytes, were given values from 0 to 3. Species in this category essentially comprise the New World analogues to the Old World "camp-following" weeds. It is believed that these are the species which exploited the compacted, disturbed, nutrient-rich soils of Indian villages, buffalo wallows, and the like. Such species played only minor roles in stable natural communities. Today, along with Eurasian weeds, they occupy more than 99% of the land in the region which is not paved over or farmed.

The remaining 55% of the native flora, 867 species (493 hydrophytes), is comprised of variously conservative species; those species were given values from 4-10, depending on their fidelity to stable native conditions. Most of the natural plant communities of the Chicago region are characterized by their inhabitance by conservative species.

Generally, the more disturbance an area has suffered since European settlement, the more likely it is to be populated prevailingly by species with values at the low end of the conservatism range. In disturbed areas, attrition of conservative elements occurs even as less conservative elements, already suited to the changes, broaden their genetic diversity and adaptation to an array of disturbed conditions. The conservative elements, supplanted in place, have neither refugia, effective migration routes, nor the time to adapt or relocate. Rather, their populations are depleted repeatedly until their ultimate extirpation.

To obtain a qualitative evaluation of a wetland site, the indices can be applied in the manner described by Swink & Wilhelm (1979) and Wilhelm & Ladd (1988).[3] According to Swink & Wilhelm, indices obtained for areas in the Chicago region are applied as follows:

> *"If the Natural Area Rating Index of a given area is 35 or 40, one can be relatively certain that there is sufficient native character to be of rather profound environmental importance in terms of a regional natural area perspective. Areas which rate in the 50's and higher are of paramount importance; such areas are extremely rare, probably occupying less than 0.02 per cent of the total land area in the Chicago region. Areas which rate less than 35 can usually be assumed to have suffered significantly from abuse or degradation."*

Many wetlands today are clearly in the latter category in that they have indices significantly lower

[3]The Natural Area Index is derived by summing the coefficients of conservatism of all the species in a unit area and dividing the sum by the number of species, yield a mean coefficient of conservatism. That mean value is multiplied by the square root of the number of species to yield the index.

than 35. Generally, the lower the index of a particular wetland, the more capable we are technically of re-establishing it or mitigating its loss with equivalent conservatism, amenities, or function.

It is yet to be demonstrated that stable natural communities, with indices in the high 30's, can be established *de novo* routinely and that such communities can be sustained at that quality level. Certainly, most open ground today, left to "succeed" on its own, is incapable of obtaining such quality. Today, the species involved in site recolonization are mostly those which have been given values of 0 to 3. Species involved in stable, diverse constellations, those given values of 4 or higher, are either absent from the region, or their populations are too disparately distributed to coalesce into any complex natural community. Such community coalescence potentials are further retarded by the fact that any succession today must take place in a universe of species that consists partly of adventive elements. Even when rich "mixes" of "pure live seed" of native species are sowed on a site, the chronic absence of fire and excessive amounts of surface runoff waters in contemporary wetland ecosystems render these plants unsuccessful in competition with non-native elements.

In the application of mitigation technologies in the Chicago region, certain ecological limitations must be kept in mind. In the modern era, there are for the most part, only about 150 native wetland species available for the spontaneous recolonization of open ground. These species have a mean value of about 2.5. This means that the highest index likely to be measured is about 30. In order to achieve higher ratings, the planting of conservative species must be prescribed. In today's restoration efforts, the planting of 60 conservative species, with a value of 4 or higher, is considered a rich planting. Present in any community is a cohort of non-conservative elements, so if the planted community can be made to consist of plants with a mean value of 4.0, a cohort of 100 species would be needed to achieve an index of 40. The highest index which has been achieved to date is 39, from 139 native species with a value of 3.34.[4]

The problem with getting conservative native plants to grow on a site is that most of our natural communities require specific hydrologies, water qualities, and soil pH levels, and they often require annual fire. Such conditions are yet beyond the technical capabilities of most engineers and plantsmen today. For most Chicago region natural wetland communities, the likelihood that each could be restored in a contemporary mitigation effort is remote.

I realize that most regions of the country have not approached their flora with this in mind. That does not mean, however, that these same relationships do not exist elsewhere or that they can be ignored simply because it is complicated and would require attention. Each region must find a rational way to codify its flora such that land custodians and resource agencies can determine the magnitude and reversibility of proposed impacts. Any manual which deals with wetland delineation in the context of the Clean Water Act must acknowledge that all wetland is not equal in its quality, function, and replaceability.

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Wilhelm, G. and D. Ladd. 1988. Natural area assessment in the Chicago region. Trans. 53rd North American Wildl. & Nat. Res. Conf. 361-375.

[4]One of the wet prairie restorations at the Des Plaines River Wetland Demonstration Project in Wadsworth, Illinois.

Table 1. Definitions of National Wetland Categories, along with the percent of Chicago region native (1570) and adventive (513) species in each Category.

Native Flora	Weed Flora	Wetland Category	Symbol	Definition
27.9%	3.7%	**Obligate Wetland**	**OBL**	Almost always occurs in wetlands under natural conditions (est. greater than 99% probability).
16.3%	5.6%	**Facultative Wetland**	**FACW**	Usually occurs in wetlands, but occasionally found in non-wetlands (est. 67-99% probability).
14.1%	13.3%	**Facultative**	**FAC**	Equally likely to occur in wetlands or non-wetlands (est. 34-66% probability).
14.4%	18.7%	**Facultative Upland**	**FACU**	Occasionally occurs in wetlands, but usually occur in non-wetlands (est. 1-33% probability).
27.3%	58.7%	**Upland**	**UPL**	Almost never occurs in wetlands under natural conditions (est. less than 1%).

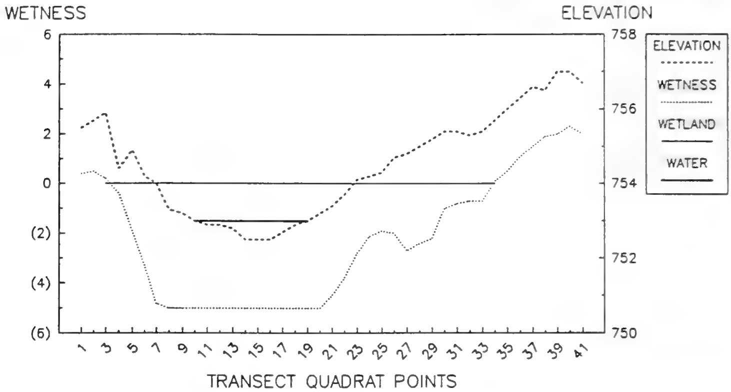

Figure 1. West Chicago Prairie. Transect consists of 41 quadrats 4 meters apart. Correlation between mean wetness coefficients (dotted line) per quadrat and topography (dashed line), shown in ft above mean sea level. The dark solid line is the normal water level. The lighter line, between quadrats 3 and 34, delineates the hydrophytic vegetation, and corresponds to the wetness axis rather than the elevation axis. (Unpublished data from Wayne Lampa, Du Page County Forest Preserve District, Du Page County, Illinois.)

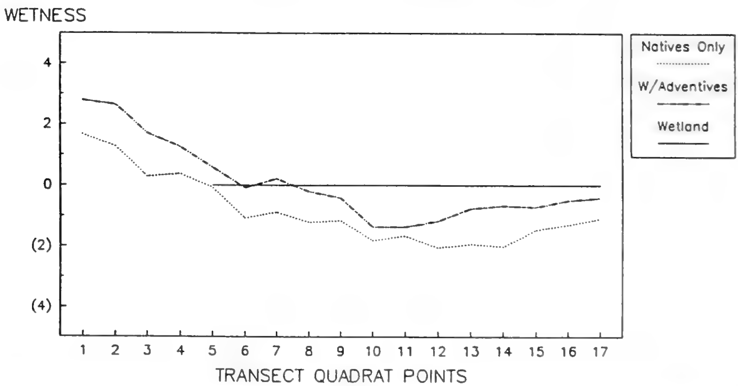

Figure 2. Disturbed wetland area in Du Page County, Illinois. Transect showing the disparity in hydrophytic vegetation assessment which can result when adventive species are included in the calculations. The dotted line shows native species only; the dotted-chained line shows the same transect, but with adventive species included. The solid line indicates the actual extent of wetland.

Book Review

Swink, Floyd. 1990. The key to the Vascular Flora of the Northeastern United States and Southeastern Canada. vi + 513 + 11 unnumbered + xii pages. Plantsmen's Publications, Box 1, Flossmoor, IL 60422. Paper. $21.95 + 3.00 shipping and handling.

The key is unique: it is a long dichotomous key that goes on and on for 513 pages of small type. The area it covers is that of *Gray's Manual* (1950). Nomenclature is of that work, too, but supplemented, when needed, by "more modern" names.

Two sections make up most of the book. The first (pages 1-82) is a key to families. The second (83-513) has keys to genera of the families and to species of the genera. Used throughout is alphabetical arrangement, the familial and generic names appearing, intermixed, in dictionary-like order. Common names equated to scientific names appear, too, alphabetically. The keys are detailed, so that when one arrives at an identification, one has gone through prose that, collectively, gives a description of the plant. Closing the book are a list of "localized species" not in the key and an excellent glossary.

Floyd Swink has been for many years the senior taxonomist at Morton Arboretum near Chicago. Probably no person in eastern North America (except maybe the late Julian Steyermark) is better acquainted with local flora.

Keying out a plant with *The Key* is a bit tedious, like the same process in *Gray's Manual*, but, with care, one can identify the plant in hand. Anyone with the patience to use *The Key* will find the work most valuable. I recommend it. *--John W. Thieret, Department of Biological Sciences Herbarium, Northern Kentucky University, Highland Heights, KY 41099*

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Editor's Note

When we changed ***Erigenia's*** format (Number 11, March 1991), we thought it would be nice to produce covers that could deliver special messages to individuals who, for example, were devoted to a particular project or had influenced others in the field of botany. We started presenting "silent tributes" with our last issue, and have decided to make these tributes known, beginning with this issue. Nancy Hart-Stieber, the artist responsible for the Mead's milkweed and leafy prairie clover drawings, has donated a great deal of time to the Illinois Native Plant Society in creating these drawings. We have received numerous requests from all over the nation for the Mead's milkweed drawing to be reproduced in magazines, newspaper articles, bulletins for threatened and endangered species, and thank-you cards for outstanding accomplishments in natural areas work. We expect the same for the leafy prairie clover after the release of this issue. We applaud Nancy for her excellent work and thank her for being so giving.

On the front inside cover of this and following issues, you will find tributes to those whom we'd like to thank for their contributions to Illinois' native flora. We would also like to share with you the "silent tribute" that went with the Mead's milkweed drawing.

The Mead's milkweed cover illustration is a tribute to Robert F. Betz for his hard work and perseverance in saving and restoring Illinois prairie. Bob's efforts in Illinois' Mead's milkweed project is greatly appreciated.

Harbinger-of-Spring OR Pepper and Salt
Erigenia bulbosa

Spring Beauty
Claytonia virginica

Guidelines for Manuscripts Submitted to *Erigenia* for Publication

Manuscripts pertaining to the native flora of Illinois and adjacent states, natural areas, gardening/landscaping with native plants, new distribution records, threats to native species, and related topics are accepted for publication. At least one author must be a member of the Illinois Native Plant Society, otherwise a $25.00 fee will be charged. Non-technical papers from the membership are encouraged. Authors will be charged $15.00 per printed page to help defray the costs of publication. Black and white photos are also accepted. Cost of each photo to the author is $20.00. These charges may be waived upon written request to the editor. Book reviews and art work will be published at no charge when space permits.

Manuscripts submitted to *Erigenia* for publication should be double-spaced throughout except for Literature Cited or References. Three copies must be submitted; photo copies of original manuscripts are acceptable during the review process. Pages should be numbered, and tables and figures should be numbered consecutively. Longer articles should follow as much as possible this general format: abstract, introduction, materials and methods, results, discussion, summary, acknowledgments, and literature cited. Titles of journals should be spelled out completely. The style for citing literature is that of the most recent issue of *Erigenia*. All measurements should be expressed in metric units with English equivalents when appropriate.

Each manuscript received will be reviewed by three or more members of the editorial board or outside reviewers. After review, authors will be notified of the acceptance or rejection of manuscripts. Accepted articles will be returned to authors for revision. *Erigenia* is prepared on a Personal Computer using WordPerfect 5.1. If a manuscript is prepared on a word processor, the editor will furnish the author with basic instructions to simplify program conversions.

Manuscripts and inquiries should be sent to:

Elizabeth L. Shimp
U.S.D.A. Forest Service
Shawnee National Forest
901 S. Commercial St.
Harrisburg, IL 62946

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Conference Proceedings
26-27 September 1992
Eastern Illinois University
Charleston

Erigenia

Number 13, June 1994

For Society membership information, write to: Lorna J. Konsis, Forest Glen Preserve, R.R. 1 Box 495A, Westville, IL 61883

The Illinois Native Plant Society is dedicated to the preservation, conservation and study of the native plants and vegetation of Illinois.

(ISSN 8755-2000)

This issue is a tribute to Ken and Lorna Konsis for their outstanding contributions to the Illinois Native Plant Society. Without their tirele efforts, the Society would not be as dynamic as it is today. Ken and Lorna, we thank you.

Proceedings of the Illinois Forest Conference: Forests of the Prairie State

26-27 September 1992
Eastern Illinois University, Charleston

Illinois is often known as "The Prairie State," reflecting the prairie heritage of much of the landscape of the state. There have been numerous conferences held in recent years about prairies in Illinois. The Executive Board of the Illinois Native Plant Society, with Jon Duerr (Kane County Forest Preserve District) as president, conceived the idea of a conference devoted to our forests. After all, it is estimated that in 1820, before European settlement, forests covered approximately 38.2% of Illinois, some 13.8 million acres (see the article by Iverson in this issue).

An organizing committee was established with Jeffrey O. Dawson (University of Illinois) as Chair. Other members included John E. Ebinger (Eastern Illinois University), Mary Hruska (Eastern Illinois University), Fran Harty (Illinois Department of Conservation), Louis R. Iverson (then of the Illinois Natural History Survey, now with the U.S.D.A. Forest Service), Ken Konsis (Vermilion County Conservation District), and Kenneth R. Robertson (Illinois Natural History Survey).

The conference, entitled "Illinois Forest Conference: Forests in the Prairie State," was held at Eastern Illinois University on September 26, 1992, with over 300 persons attending. This issue of *Erigenia* contains papers and abstracts presented at the conference. A Conference Program is included at the beginning of this issue.

The Illinois Native Plant Society wishes to thank the following organizations for their sponsorship of the Conference:

Botany Department
Eastern Illinois University
Charleston, IL 61920

Champaign County Audubon Society
P.O. Box 882
Urbana, IL 61801

Champaign County Design and Conservation Foundation
10 G.H. Baker Drive
Urbana, IL 61801

Department of Forestry
University of Illinois
Urbana, IL 61801

Grand Prairie Friends of Illinois
P.O. Box 36
Urbana, IL 61801

Illinois Council on Forestry Development
Department of Forestry
University of Illinois
Urbana, IL 61801

Illinois Department of Conservation
Division of Natural Heritage
Nongame Wildlife Checkoff Fund
Springfield, IL 62706

Illinois Native Plant Society Chapters

Illinois Natural History Survey
607 E. Peabody Drive
Champaign, IL 61820

U.S.D.A. Forest Service
Shawnee National Forest
901 S. Commercial St.
Harrisburg, IL 62901

Conference Schedule
Saturday, 26 September 1992

9:00 Opening Remarks and Welcome
John E. Ebinger, Eastern Illinois University
Kenneth R. Robertson, President, Illinois Native Plant Society

9:15 Opening Address
An Overview of Illinois Forest Resources, Louis R. Iverson, Illinois Natural History Survey

10:00 Session A
Woody Plants of Illinois Forests, Kenneth R. Robertson, Illinois Natural History Survey
The Forest Stewardship Program in Illinois, Gary Rolfe and Stephanie Brown, University of Illinois
Diseases of Illinois Forests, H. Walker Kirby, University of Illinois
Higher Fungi of Illinois Forests, Andrew Methven, Eastern Illinois University and Walter Sundberg, Southern Illinois University, Carbondale

10:35 Session B
Wild Flowers of Illinois Forests, Floyd Swink, The Morton Arboretum
Production of Plant Materials for Reforestation and Savanna Restoration, Stewart Pequignot, Illinois Department of Conservation
What is Causing the Death of Pine Trees in Illinois? James Appleby, University of Illinois
Stewardship of Forested Nature Preserves, Gretchen Bonfert, Illinois Nature Preserves Commission

11:10 Session C
Vegetation Dynamics of the Prairie/Forest Interface at Coles Creek Hill Prairie, William Werner, Jr., Carlinville, Illinois
State and Federal Programs to Assist Forest Management and Stewardship, R. Daniel Schmoker, Illinois Department of Conservation
Exotic Species in Illinois: Impacts and What Can We Do to Deal With Them, John Schwegman, Illinois Department of Conservation
Forest Root Structure: Root Symbionts and Their Function, Jeffrey Dawson, University of Illinois

11:45 Lunch

12:30 *Cowboy Poetry*, Philip Robertson, Southern Illinois University

1:15 Luncheon Address
Fighting for Survival: A Plan for Endangered Plants, Robert H. Mohlenbrock, Southern Illinois University

2:00 Session D
Diversity and Management of Forest Communities in the Shawnee National Forest, Lawrence Stritch, U. S. D. A. Forest Service
Structure and Function of Illinois Forested Wetlands under Disturbed Hydrologic Regimes, Sandra Brown, University of Illinois
The Occurrence of Prairie Fires in Illinois and Adjacent Midwestern States During the Period 1673-1873, William E. McClain, Illinois Department of Conservation
The Challenge: Biography of Illinois, Jon Duerr, Kane County Forest Preserve District

2:35 Session E
Cultivating a Land Ethic: Who are the Stewards of Illinois Forests? Timothy Marty, University of Illinois
The Bottomland Forests of the Southern Illinois Area, Philip Robertson, Southern Illinois University
Deer in Illinois Forests, Todd Strole, Illinois Department of Conservation
A Sampling of Arthropod Diversity from a Central Illinois Woodland, Michael Jeffords and Susan Post, Illinois Natural History Survey

3:10 Session F
Dynamics of Bird Populations within Fragmented Forest/Agricultural Landscapes, Jeffrey D. Brawn and Scott K. Robinson, Illinois Natural History Survey
Upland Forests of Central Illinois: Past and Present, Dr. Roger Anderson, Illinois State University
Effects of Riparian Buffers in Reducing Agricultural Pollution, David Kovacic, University of Illinois
The Presettlement, Present, and Future Forest of the Shawnee and Ozark Hills Regions of Illinois: Management Implications, James Fralish, Southern Illinois University

3:45 Session G
Threatened and Endangered Animals of the Illinois Forests and Savannas, James Herkert, Illinois Nature Preserves Commission
Illinois Savannas: Past and Present, Victoria Nuzzo, Native Landscapes, Rockford, Illinois
Native Trees for Urban Use: Urbanization of Illinois Forests, George Ware, The Morton Arboretum
The Impact of Climate Change on Forest Ecosystems, Evan DeLucia, University of Illinois

4:30 Closing Address
Floristic Changes after Five Growing Seasons in Burned and Unburned Woodland, Gerould Wilhelm and Linda Masters, The Morton Arboretum

5:15 Closing Remarks, Jeffrey Dawson, Chair, Organizing Committee

Forest Resource Trends in Illinois

Louis R. Iverson[1]

U.S.D.A. Forest Service
Northeastern Forest Experiment Station
359 Main Road
Delaware, OH 43015

INTRODUCTION

Even though forests occupy only 12% of the land area of Illinois, they play a valuable role in the health of the state's environment and that of its citizens. Many of these benefits have been reviewed in *Forest Resources of Illinois: An Atlas and Analysis of Spatial and Temporal Trends* (Iverson *et al.* 1989), and summarized in the *Forests of Illinois* (Iverson *et al.* 1991). Readers are encouraged to obtain copies of these documents from the Illinois Natural History Survey. The purpose of this paper is to focus on current trends in Illinois forests and to report information obtained following these earlier publications, specifically, changes in forest cover from 1820 to 1985, current (1990) trends and patterns of forest land for a portion of south-central Illinois, and trends in forest composition and diversity, timber growth and harvest, value for wildlife habitat, and value for carbon sequestration.

Trends in Forest Area from 1820 to 1985

Illinois forests have undergone drastic changes since European settlement. In 1820 there were 13.8 million acres (5.6 m ha) of forest in the state (Fig. 1a, see also the large wall map by Iverson and Joselyn 1990, available at no charge from the author). Only 31% (4.26 million acres or 1.72 m ha) of the forest area present in 1820 remained in 1985 (Fig. 1b shows forest distribution as of 1980); essentially all (except for about 11,600 acres or 4700 ha) of the present forests are secondary or cutover timberland. Illinois also ranks 49th (Iowa is 50th) in the percentage of land remaining in the vegetation types (Kuchler 1964) on the land when the European settlers arrived (11 percent). The pattern and rate of deforestation in the latter part of the last century, estimated at 1.13% per year (Iverson 1991), rivals and even surpasses that of any tropical deforestation occurring today.

However, forest area has recently been increasing in Illinois. The lowest estimate of forest area in the state was made by Telford (1926), who estimated forest area to be only 3.02 million acres (1.22 m ha) compared to estimates of 4.0 million acres (1.62 m ha) in 1948 (USDA Forest Service 1949), 3.87 million acres (1.57 m ha) in 1962 (Essex and Gansner 1965), and 4.26 million acres (1.72 m ha) in 1985 (Hahn 1987). Forest area increased by 10% from 1962 through 1985 due primarily to reduced cattle production in the state during that period with subsequent conversion of hayland and pastures to secondary forest. Recent farm programs such as the Conservation Reserve Program have provided incentive to convert additional marginal acres to forest land.

When the state is evaluated according to five ecologically based regions (Fig. 2), changes in forest area since 1820 show similar patterns: major declines in forest area are dramatic between 1820 and 1924, with slow increases in area since 1924 (Fig. 3). The only region to lose forest area between 1962 and 1985 was the South-Central Region, a group of 31 counties south of the Shelbyville moraine and north of the Shawnee Hills. Figure 4 is a county map showing trends of forest area between 1962 and 1985. Counties that lost more than 5,000 acres (2,000 ha) of forest land between 1962 and 1985 were Bond, Clark, Clinton, Fayette, Franklin, Gallatin, Hamilton, Jasper, Lawrence, Marion, Montgomery, Perry, Richland, Shelby, St. Clair, Wabash, and Wayne. Counties from other regions that lost more than 5,000 acres were

[1]The majority of this work was conducted while the author was employed by the Illinois Natural History Survey, Champaign, IL.

Alexander and Massac from the Southern Unglaciated Region, Greene from the Western Region, and Lake from the Northern Region. However, an additional 38 counties gained more than 5,000 acres of forest land during this interim, mostly from the northern two-thirds of the state (9 of 12 counties in the Northern Region, 11 of 31 in the Grand Prairie Region, 14 of 21 in the Western Region, 1 of 31 in the South-Central Region, and 3 of 7 in the Southern Unglaciated Region. Clearly, the northern counties generally have increased in forest area (especially those along the major river systems) while the southern portion of the state (except for the Shawnee National Forest counties) suffered significant forest losses during the same period.

Forest Pattern and Trends in South-Central Region

To better understand the temporal and spatial patterns of forest patches in the South- Central Region, a detailed analysis of one 1990 Landsat TM scene, that covered 13 counties was performed. This region was selected for intensive study since it was the only one with forest loss during 1962-85. The satellite data were at a resolution of 98 x 98 ft (30 m x 30 m), so that forest patches as small as approximately 0.25 acre (0.1 ha) could be identified. The distribution of the forest is highly fragmented and primarily distributed adjacent to streams. Given the constraints of a completely different methodology, direct comparisons of trends between the Forest Service's 1985 estimate (a sampling procedure) and the 1990 assessment (satellite image classification) are not reliable. Still, it is useful to estimate forest area and the amount of fragmentation in this portion of the state.

According to the satellite data, the forest area for the 13 counties was substantially lower in the 1990 estimate compared to the 1985 or 1962 estimates of the Forest Service (Fig. 5). However, it is likely that many of the changes can be attributed to variation in the methodology -- the classification of the satellite data did not include some areas interpreted by the Forest Service as forest in 1985. Still, the region of satellite analysis was the one portion of the state that showed a decline in forest area between 1962 and 1985 (Figs. 3-4), and this trend might have continued since 1985.

The satellite data also show the extraordinarily fragmented nature of the forests. Fragmentation of forest habitat generally has negative implications for wildlife, especially for neotropical migrant birds that need large blocks of uninterrupted forest for successful nesting. As large tracts of forest are broken into small isolated woodlots, more forest edge is created and there are more opportunities for edge-adapted species, most commonly the cowbird, to invade the area and prevent adequate nesting for many forest songbirds. Most of the forest parcels in this region are less than 1 acre (0.4 ha) in size (Fig. 6). In these forest patches, as small as about 65 by 65 ft (20 by 20 m), trees dominate the area, even in backyards, so that the 98 by 98 ft (30 by 30-m) pixel would classify as forest in the satellite imagery. Parcels larger than 40 acres (16 ha) are much less frequent (range: 95 parcels in St. Clair County to 269 parcels in Fayette County). When one considers the larger forest-patch sizes (e.g., 600 acres or 243 ha) approaching that needed to support forest interior birds, the range is 3 in Montgomery County to 17 in Fayette County for a total of 131 patches in the entire 13-county area (Fig. 6).

When evaluated on a per-unit-area basis (density of forest patches per township-size area of 36 mi^2 or 93.2 km^2), one can better understand the "population dynamics" of the forest patches. A range of 211 to 770 forest patches less than 1 acre can be found in St. Clair and Jefferson Counties, respectively (Fig. 7). The data also show the paucity of large forest patches in the region. Of all patches larger than 40 acres, only 5.2 patches of this size can be found on average in each township of St. Clair County, ranging up to 14.1 patches per township in Jefferson County. Jefferson originally (ca. 1820) had 73% forest cover, at least 20% higher than any other county in the study area (Iverson *et al.* 1989); so it would be expected to have the highest density of forest patches remaining. For the entire 13-county area, an average of 10.1 forest patches per township can be expected--about one patch for each 4 mi^2 (10 km^2). A cautious comparison of these data can be made to data from a study by Iverson *et al.* (1989). Using U.S. Geological Survey land-use data for 1974-79, Iverson *et al.* (1989) calculated a density of forest patches larger than 40 acres of 7.1 to 9.7 per township in this region. If the comparison is reliable, these data represent a slight increase in patch density over the past 11 to 16 years. This trend could

be achieved in at least two ways: (1) additional patches of at least 40 acres have been added to the pool due to regrowth or aggregation of smaller patches, or (2) some large patches have been split into two or more medium-size (but still larger than 40 acres) patches due to continued fragmentation. On the basis of these data and a reevaluation of the data in Iverson *et al.* (1989), the latter is most likely the case.

By overlaying the forest classification from satellite data with the streams from the area (1:100,000 digital line graph files), we can estimate the proportions of the Illinois forests within certain distances of the streams. For this area, no less than 78% of the forests is within 984 ft (300 m) of the streams (Fig. 8); a full 22% of the forests is within 98 ft (30 m) of the streams. An evaluation of the distribution of forests circa 1820 (Fig. 1) shows that the proximity of streams and forest in this region has historically been the case; the streams were efficient fire barriers which reduced the frequency of fire near them. As evidence continues to mount on the value of riparian forests in maintaining stream health (the reverse is also true), it can be seen that the majority of forests in Illinois are well situated on the landscape.

Changes in Forest Composition

The composition of Illinois forests has changed dramatically over the past three decades. Today, about one-half of the commercial forest acreage (2.03 million acres or 0.82 m ha) is oak-hickory, one-fourth is maple-beech (1.05 million acres or 0.42 m ha, almost exclusively sugar maple), and one-sixth is elm-ash-soft maple (0.72 million acres or 0.29 m ha) (Fig. 9). The remaining forest types (white-red-jack pine, loblolly-shortleaf pine, oak-pine, and oak-gum-cypress) account for an additional 217,000 acres (87,850 ha) of commercial forest land. However, in 1962, there was much more acreage of oak-hickory and elm-ash-cottonwood and little area dominated by the maple-beech type; the maples (especially sugar maple) have increased by a factor of 41 since that time, whereas the oaks have been reduced by 14% and the elms have been cut in half (Fig. 9). The loss of oak-hickory forest is largely explained by the maple "takeover," that is mature oak-hickory forests are unable to regenerate because tree seedlings are intolerant of excessive shade, whereas maple seedlings thrive in the shady environment and are positioned for rapid growth and dominance once the overstory is removed or dies (Ebinger 1986). This takeover by maple is common throughout the northeastern quarter of the country, with red maple dominant in many of the more states (Powell *et al.* 1993). The reduction of elm-ash-soft maple is largely due to the effects of Dutch elm disease and the conversion to agriculture of bottomland forests that once supported these trees (especially in the South-Central Region). These trends also are evident by the age-class distribution of the major forest types (Fig. 10). The oak-hickory type dominates in the older age classes, while the maple-beech type dominates in the younger age classes; as time passes, maples will continue to increase in dominance. The changing composition of the forests will continue to have wide-ranging implications with respect to plant and animal habitat as well as timber resources.

Botanical Diversity

The Illinois Plant Information Network (ILPIN) was queried regarding the county distribution of forest-associated taxa within the state (Iverson and Ketzner 1988). The wide range in latitude from north to south accounts for a considerable range in climate and geomorphic conditions, and, subsequently, a remarkable diversity of habitats. For example, 261 species of trees (native and introduced) have been recorded in Illinois. Southern counties have the greatest variety: Jackson has 145 species, Pope 129, and Union 128; several northeastern counties also have high diversity due to varied landscapes and escaped cultivars from the Chicago Region (Fig. 11). Also, there are 284 taxa of shrubs (some of which can be called trees) and 47 taxa of lianas reported for the state. Overall, 508 taxa of woody plants have been recorded; 370 are native and 138 are introduced.

Besides the woody flora, Illinois forests are exceptionally rich in nonwoody taxa. Including woody species, there are 1,581 forest-associated plant taxa in the state, 1,414 (89%) of which are native. Jackson County, a botanicially rich southern county that includes Southern Illinois University, from which numerous botanical forays have been conducted, has 954 forest-associated native taxa on record, while Warren County in the northwest (not near a botanical center) has had only 262 taxa

recorded (Fig. 12). Again one can see the higher botanical diversity levels in the southern counties, with species richness in Appalachian flora, and in the northern counties, with richness in northern temperate flora. Relatively lower diversities of forest-associated species are found naturally in the counties formerly dominated by prairie.

The forests of Illinois harbor nearly half of the state's threatened and endangered species even though forests occupy only 12% of the land area. The importance of maintaining high-quality forests as refuges for these taxa cannot be overemphasized, especially in the face of extreme pressures from human activity.

The major problem related to biodiversity in Illinois no longer is from land-use change and habitat conversion, a major concern until 20 to 30 years ago. Rather, it is now the invasion of exotic species, many of which compete aggressively with the native species, eventually replacing them. The proportion of the Illinois flora that is exotic has reached 28%, according to the ILPIN data base. Published vascular plant floras of the state dating back to 1846 show a continued rise in the percentage of exotics (Henry and Scott 1980). To date, about 130 exotic species from Illinois forests have been recorded, according to ILPIN. More than 50 exotic species have been recorded in each of several counties, especially in the northeastern and southwestern part of the state. The numbers of taxa per county probably are even higher because routine collection of exotics is not a high priority of most field botanists. Some of the major pests include *Alliaria petiolata* (garlic mustard), *Lonicera maackii* (amur honeysuckle), *Lonicera tatarica* (tartarian honeysuckle), *Rhamnus cathartica* (common buckthorn), *Rosa multiflora* (multiflora rose), *Lonicera japonica* (Japanese honeysuckle), and *Pueraria lobata* (kudzu-vine). The problem of exotics is increasing in severity and scope in the forests of Illinois.

Timber volume and growth

The total volume of growing stock in 1985 was 4.8 billion feet^3 (135 million m^3), 40 percent greater than the 3.4 billion feet^3 (96.3 million m^3) reported for 1962 (Hahn 1987). Estimates of net volume for 1985 showed the prominence of oak and hickory in commercial forests, with considerable amounts of ash, black walnut, cottonwood, elm, maple, and sycamore. The 1985 volumes averaged 1,200 feet^3/acre (83.9 m^3/ha) of commercial forest land in Illinois.

The trends in volume since 1948 for several major species groups are shown in Figure 13. For all groups except elm, there has been a dramatic increase in volume since 1962. The elms have declined since 1948 due to bottomland conversion to agriculture and Dutch elm disease. White and red oaks and black walnut had decreased in volume from 1948 to 1962, but showed increases from 1962 to 1985. The hickories, maples, and ashes have increased in volume since 1948.

Estimated net annual growth in 1985 (Hahn 1987), totaled 96 million feet^3 (2.72 million m^3) in growing stock (437 million board feet of sawtimber growth). More than 42% of net annual sawtimber growth was accounted for by oaks, with another 10% by soft maple, 6.3% by ashes, 3.7% by black cherry, 3.3% by hard maple, and 3.2% by black walnut. Only elm and black ash had negative growth rates between 1962 and 1985, attributable to Dutch elm disease and the clearing of bottomlands during this period.

In contrast to the 1985 data, the 1962 inventory showed annual growth of 125 million cubic ft^3 (3.5 million m^3) in growing stock, an increase of 30 percent. The lower annual growth and higher volumes in 1985 compared to 1962 indicate that growth has outstripped removals in the past several decades but that growth rates may be declining due to maturing forests. When evaluated by county, trends in volume during 1962-85 show large percentage increases for all northern and central counties (except Whiteside), but generally lower or even negative volume changes for south-central counties (Fig. 14). This trend can be linked primarily to area changes for the region discussed earlier (see Fig. 3).

Timber harvest

Illinois ranks fifth in the nation in demand for wood but 32nd in the production of wood; as a result, the state imports much of this wood from other states. Therefore, it is surprising to discover that 14 % of the wood harvested in Illinois is processed in

neighboring states and then imported back into Illinois (Blyth *et al.* 1987). Currently, the annual growth of timber (96 million cubic ft^3 or 2.72 million m^3) exceeds timber removals (68.6 million cubic ft^3 or 1.94 million m^3), so a higher proportion of Illinois' demand for wood could be met within the boundaries of the state if it had processing facilities. With judicious management of an increased harvest, negative effects on the environment could be minimized and multiple benefits achieved. Local markets for Illinois hardwoods could be an incentive for reforestation with native trees and as provide needed local employment, especially if value-added industry located in the resource-rich regions.

An enormous quantity of firewood is harvested from Illinois forests -- nearly 2 million cords a year (Blyth et al 1985). In fact, about 43% of all trees removed in a given year in the state are used for firewood! However, the demand for firewood does not present a major threat to the state's forests, because 75% of the firewood cut is from dead trees, mostly from forests in the heavily populated northeastern counties (Fig. 15). Trees cut for sawlogs are primarily from the southern half of the state (Fig. 16); the major counties cutting sawlogs in 1983 were Franklin, Fulton, Jackson, and White (more than 6 million board feet per county).

Sequestration of Carbon

Because of the massive changes in total forest volume in Illinois over the past several decades, the amount of carbon being sequestered into forest biomass in the state also has changed considerably during that time. From 1948-62 there was a slight loss (0.15 million metric ton) of total forest volume due to conversion of forestland to other uses (Fig. 17). This loss was offset by an increase in the volume contained within extant forests (0.06 million metric ton) and the harvesting of wood products which put 0.29 million metric ton of carbon into long-term storage. The result was that forestlands were a net sink of 0.20 million metric ton of carbon per year during 1948-62. After 1962 there was a gain in forest land and particularly a gain in forest volume per unit of forest land, with a resulting sequestration of about 1.37 million metric tons (1.51 million tons) of carbon per year (Fig. 17). Carbon sequestration into long-term storage of wood products also increased between the two time periods, though not as significantly as the change in land use or volume. This net sink from Illinois forest lands helps balance the carbon cycle in the state, but still represents only about 2.7% of the total emissions of carbon that the people of Illinois contribute to the atmosphere each year --51.55 million metric tons (56.82 million tons) in 1988.

Trends in Wildlife Habitat

The forests of Illinois provide the major habitat for numerous wildlife species. Losses in the quality and quantity of that habitat severely affect wildlife populations (Illinois Wildlife Habitat Commission 1985). One method of summarizing the value of wildlife habitat in Illinois is based on land use. One method for calculating an index of wildlife habitat is presented in Graber and Graber (1976); revised calculations based on current data are given in Iverson *et al.* (1989). The index devised by Graber and Graber is based on the proportion of a particular habitat type within a given area, the availability of that habitat type within the state or region, the trends associated with that habitat over the previous decade, and the "cost" of a given habitat measured in years required to replace the ecosystem. A summary of habitat factors for Illinois as of 1985 is presented in Table 1. By this calculation, more than three-quarters of the wildlife habitat (88 of 115.7 habitat factor points) is derived from forests. Elm-ash-cottonwood rates highest because this forest type has been disappearing so quickly over the past two decades (Fig. 9). Values for oak-hickory would be higher except that numbers in older age classes are increasing as secondary forests mature, even though numbers in younger age classes are decreasing (Fig. 10). A minor rating was earned by maple-beech because this forest type has increased so dramatically in recent years (Fig. 9). Scores for habitat factor generally were much more favorable for wildlife habitat in the southern half of the state, which is more heavily forested. In fact, total habitat-factor scores for the South Region were twice those of the Central Region, with the North Region in between (Iverson *et al.* 1989).

By comparing habitat-factor scores of Iverson *et al.* (1989) for 1985 to those of Graber and Graber (1976) for 1973, one can evaluate temporal trends in habitat, and the role of forest land in those changes. This evaluation was possible for the North, Central,

and South regions. Caution is advised in this comparison, however, because these regions are not an exact match geographically. It was not possible to directly compare habitat scores between dates because of slight variations in the methodology. However, by calculating the percentage of the habitat factor occupied by each land type for the two dates, relative contributions to habitat by each land type can be calculated over time (Fig. 18), as can total contributions of forest land to habitat. For example, in the north, the cumulative percentage from forest was 53.4 in 1973 and 65.3 in 1985 -- an increase of 22% in relative habitat factors from forests in that region (Fig. 18a). This increase is due mostly to large increases in relative habitat factors for the elm-ash-cottonwood and pine types and a decrease in marsh habitat. In the Central Region, relative habitat increased from 71.6 to 76.1% (Fig. 18b), while in the south, relative habitat decreased from 88 to 84% (Fig. 18c). In all regions there were increases in relative habitat factors for elm-ash-cottonwood because that type decreased in area by nearly 50% between 1973 and 1985 (Fig. 9). All regions showed a decrease in relative habitat value for the oak-hickory and maple-beech types, though for different reasons. The oak-hickory type decreased because large increases in availability were apparent in the older (> 60 yr) age classes even though the younger age classes had decreasing acreages. The maple-beech type decreased in relative habitat value because of the extremely large increases in area for all age classes. This resulted in low changing availability scores which, in turn, lowered the habitat-factor scores.

Another way to evaluate the trends in relative habitat factor scores for forest types between 1973 and 1985 is to plot the percentage changes during the period (Fig. 19). Here we see increases in relative habitat factors in all three regions for elm-ash-cottonwood, an increase in pine for the North Region, and an increase in oak-hickory in the South Region. Scores for pine increased in the north because its availability increased, especially in the older (> 40 yr) age class. Similarly, oak-hickory increased in the south primarily because of a negative changing availability in the younger age classes. All other forest types showed decreases between 1973 and 1985. Especially apparent is the decrease in all regions of the score for maple-beech. Pine decreased in the south because of increasing availability in that region. Overall, the data show the extremely high value, and an increasing value of forest habitat relative to other habitat, for wildlife habitat across the state.

CONCLUSIONS

A review of some of the trends apparent in Illinois forests over the past several decades lead to several conclusions:

1. The state's forests are now increasing in area when evaluated statewide, probably due to several incentive and educational programs as well as to an overall reduction in pastureland during this period. The exception may be in the South Central region where fragmentation apparently is continuing.

2. Most of the forests historically and currently are associated with the state's stream network. In the south-central portion of Illinois, 78% of the forest land is within 300 m of the streams.

3. Although forest area is increasing overall, the composition of the forests is changing dramatically, as it is in many states in the northern and northeastern United States. Maple species are replacing much of the oak-hickory in forests and dominating new forest land succeeding from abandoned pastures. The oak-hickory forests are not being regenerated and will continue to decrease in area and importance.

4. The botanical diversity of the state is being carried, in large part, by its forests. More than half of the native flora and more than half of the threatened or endangered flora are found in Illinois forests. Invasion by exotic species, one of the most serious problems facing these forests, continues to increase both in severity and scope.

5. Timber volume increased by 40% between 1962 and 1985. Volumes of most forest types have increased substantially except for elm-ash-cottonwood, which has decreased because of Dutch elm disease and conversion of bottomland forests. However, net annual growth over all forests in the state was 30% higher in 1962 than in 1985, showing the aging nature (with concomitant slowing of growth rates) of our secondary forests.

6. Because of the dramatic increases in volumes, Illinois forests served as a large carbon sink during 1962-85. The estimated annual sequestration of carbon into the state's forests is 1.37 million metric tons, enough to counteract about 2.7% of the total emissions of carbon into the atmosphere by the people of Illinois.

7. According to one index, more than 75% of the wildlife habitat in the state is within its forests. Further, in the northern two-thirds of Illinois, the relative contributions of forest land to wildlife habitat has been increasing over the past two decades.

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Table 1. Habitat factors for Illinois, 1985, calculated according to Graber and Graber (1976).

Land type	Habitat factor	% of wildlife habitat
Forest		
Pine	5.70	4.9
Oak-hickory	30.07	26.0
Oak-gum-cypress	11.97	10.3
Elm-ash-cottonwood	40.19	34.7
Maple-beech	0.14	0.1
Subtotal		76.0
Nonforest		
Cropland	0.29	0.3
Pasture/hayland	10.01	8.7
Prairie	1.46	1.3
Marsh	15.28	13.2
Water	0.38	0.3
Urban, residential	0.03	0.0
Fallow	0.19	0.2
Subtotal		24.0
Total	115.73	100.0

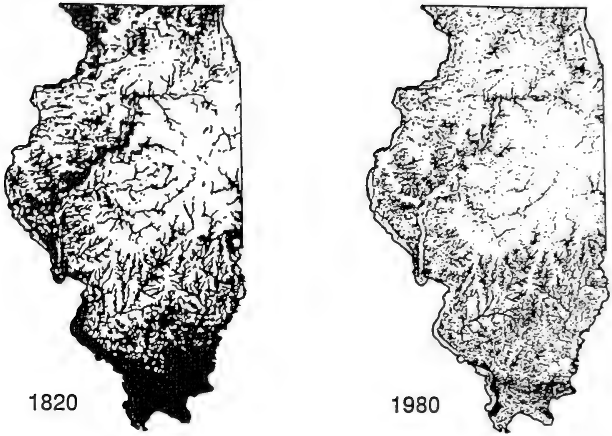

Figure 1. Forest coverage in Illinois in (a) 1820 and (b) 1980. Sources: Anderson 1970 and U.S. Geological Survey land-use data, 1973-1981.

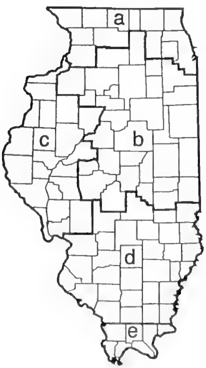

Figure 2. Illinois regions: (a) Northern, (b) Grand Prairie, (c) Western, (d) South Central, and (e) Southern Unglaciated.

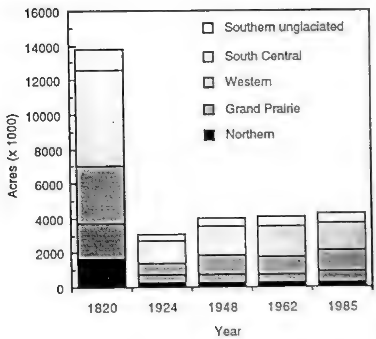

Figure 3. Trends in forest area in Illinois by region, 1820-1985.

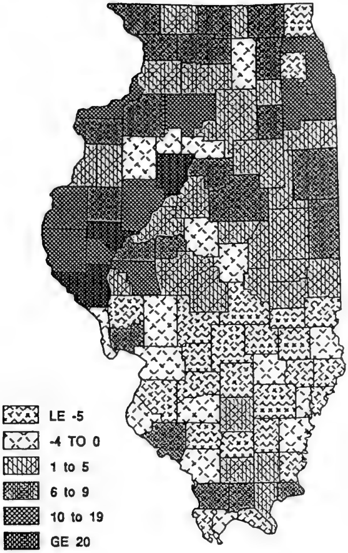

Figure 4. Distribution of forest-area trends (acres x 1000) in Illinois by county, 1962-1985.

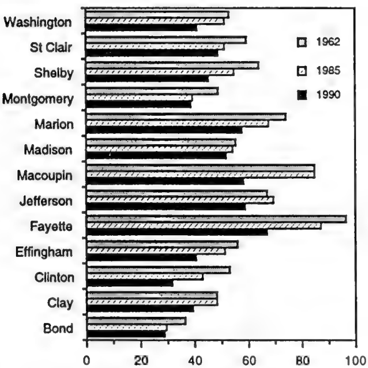

Figure 5. Forest-area trends (1962-1990) for 13 counties in south-central Illinois.

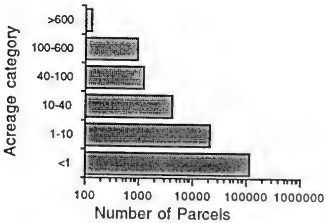

Figure 6. Number of forested parcels, by acreage class, for each of 13 counties in south-central Illinois, as detected by satellite in 1990.

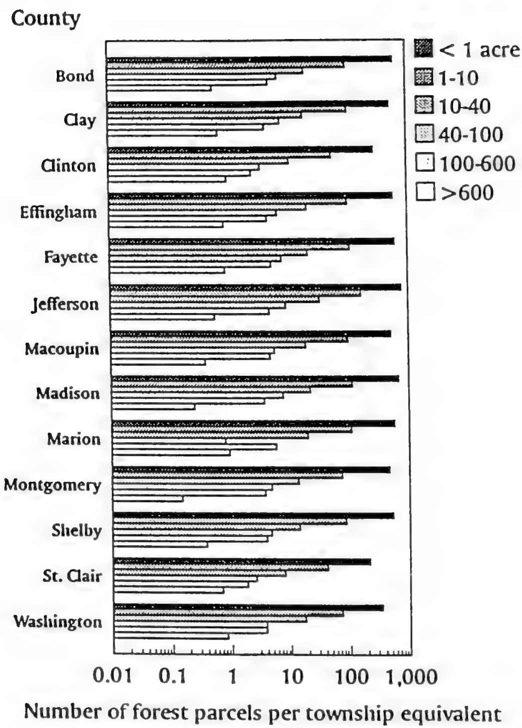

Figure 7. Number of forested parcels, by acreage class, per township equivalent (36 miles^2 or 93.2 km^2) for each of 13 counties in south-central Illinois, as detected by satellite in 1990.

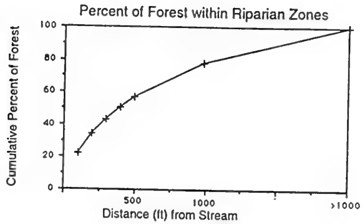

Figure 8. Distribution of forests at various distances from streams in the 13 counties in south-central Illinois.

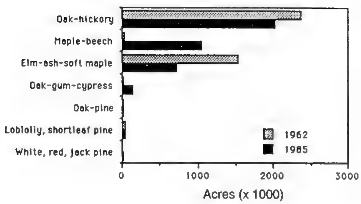

Figure 9. Composition of Illinois commercial forests, 1962 and 1985.

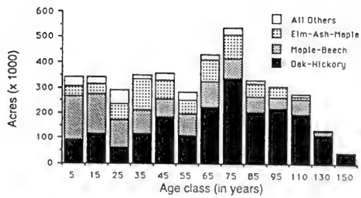

Figure 10. Acreage by age class of the major forest types in Illinois, 1985.

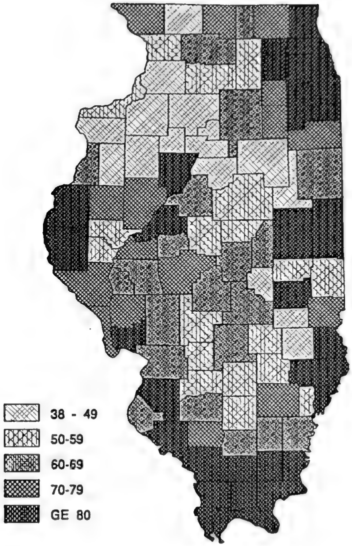

Figure 11. Number of tree taxa in Illinois by county (includes native and introduced species).

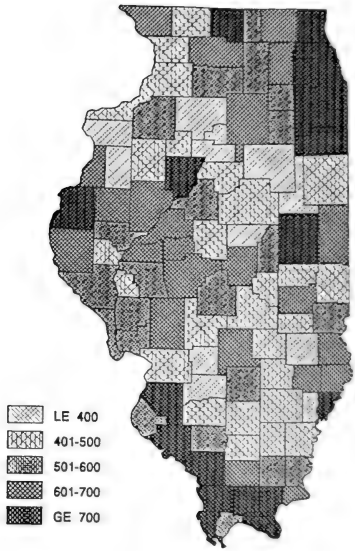

Figure 12. Number of forest-associated native taxa in Illinois, by county.

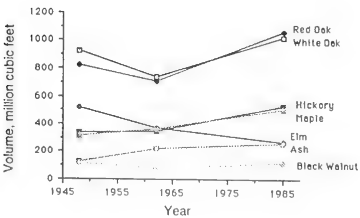

Figure 13. Trends in forest volume in Illinois by type, 1948-1985.

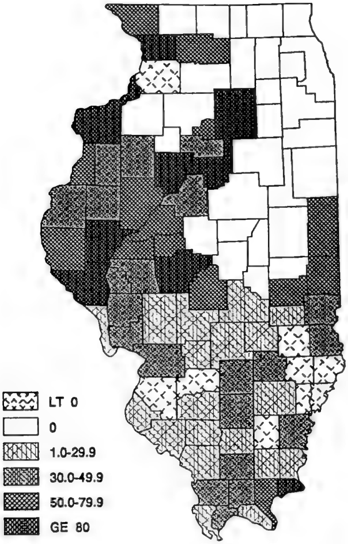

Figure 14. Trends in forest volume in Illinois by county, 1962-1985 (millions of cubic feet of sawtimber). [Note: for 28 counties with no coded change, no specific data were available for 1962 volumes; over all these prairie counties, however, there was a 269% increase in volume between 1962 and 1985.]

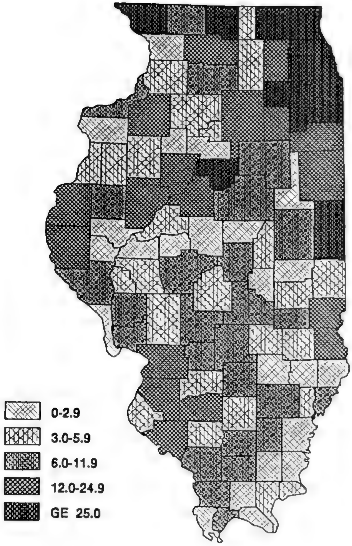

Figure 15. Fuelwood production in Illinois by county (standard cords x 1000), 1983.

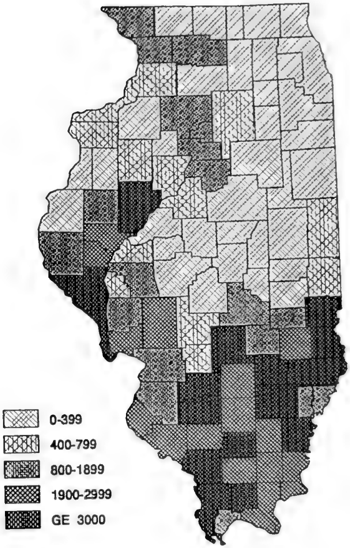

Figure 16. Sawlog production in Illinois by county, 1985 (thousands of cubic feet).

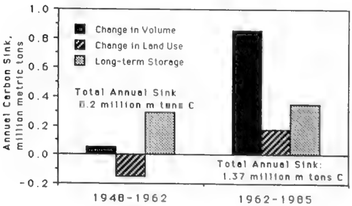

Figure 17. Carbon sinks and sources for Illinois forest lands, 1948-1985. Volume represents changes in carbon due to changes in volume per unit area of forest. Land indicates carbon changes because of land use changes, and storage represents long-term storage of carbon from harvesting of timber products.

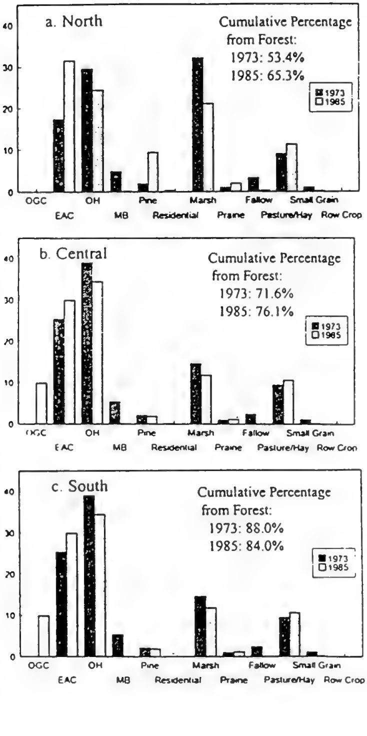

Figure 18a, b, c. Relative habitat factors for three regions of Illinois, 1973-85, according to the index of Graber and Graber (1976). OGC = oak-gum-cypress, EAC = elm-ash-cottonwood, OH = oak-hickory, MB = maple-beech.

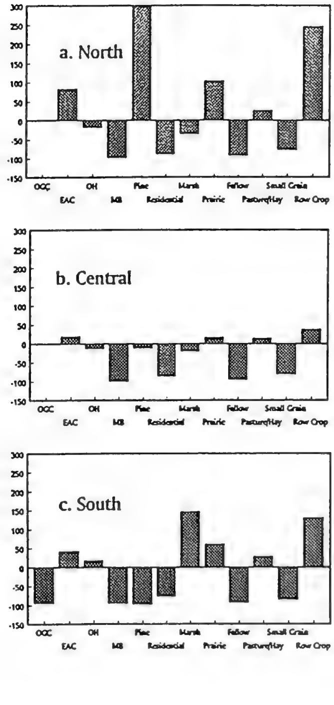

Figure 19a, b, c. Percent change of relative habitat factors in Illinois between 1973 and 1985. OGC = oak-gum-cypress, EAC = elm-ash-cottonwood, OH = oak-hickory, MB = maple-beech.

Woody Plants of Illinois

Kenneth R. Robertson

Center for Biodiversity
Illinois Natural History Survey
Champaign, IL 61820

ABSTRACT

This paper contains a list of the native and naturalized woody plants of Illinois, along with summary information derived from this list. A total of 315 species of woody plants are native to Illinois, representing 56 families and 113 genera. There are 167 native species of trees, 166 shrubs, and 31 lianas (some species belong to more than one habit category). By far the largest woody plant family is the Rosaceae (rose family), with 74 native species in 11 genera. The Fagaceae and Salicaceae are the next most numerous woody families, each with 22 species native to the state. Conifers are poorly represented in Illinois, constituting only 6.6% of our native trees and 2.4% of native shrubs. Approximately 25% of the native tree species that occur in the continental United States occur naturally in Illinois. A total of 125 species of woody plants have been introduced and become naturalized in Illinois, including 57 trees, 76 shrubs, and 10 lianas (some species can be either trees or shrubs).

INTRODUCTION

As related elsewhere in these Proceedings, there is a wide diversity of forest types in Illinois. Concomitantly, the state also has many kinds of trees, shrubs, and woody vines. Of the approximately 2,300 taxa of vascular plants native to Illinois, 375 taxa, or approximately 16%, are woody.

There have been several publications on woody plants of Illinois. Perhaps the most familiar is *Forest Trees of Illinois*, published by the Illinois Department of Conservation. The first edition by Mattoon and Miller was published in 1927; G. D. Fuller and others revised the publication in 1946 and 1955; R. H. Mohlenbrock has written several editions, the first in published in 1970 and the most recent in 1990. All editions of Forest Trees of Illinois have line drawings showing the characteristic features of the species listed, along with short descriptions. More recent editions show distributions by county. Ebinger and Thut (1970) is an important regional treatment of the woody plants of east-central Illinois.

Two publications from the Illinois Natural History Survey are long out-of-print, but they contain information still useful today. Miller and Tehon's *The Native and Naturalized Trees of Illinois* (1929) has photographs of herbarium specimens, and the text has useful information on the habitats, uses, and historical records for large tree specimens. The *Fieldbook of Native Illinois Shrubs* (Tehon 1942) includes woody vines as well as shrubs and has line drawings, short descriptions, and brief accounts of distributions and habitats.

METHODS

The most recent listing of the woody plants of Illinois is in Appendix iii of Iverson *et al.* (1989). A modified version of this list with selected information is included as Table 2 in this present paper; summary information derived from this list is presented in Table 1. In preparing Tables 1 and 2, certain information from Iverson *et al.* (1989) was entered into FileMaker Pro data base on a Macintosh computer. Information was added on endangered or threatened status in Illinois (Illinois Endangered Species Protection Board (1994), Herkert and Kruse (1992), and Herkert (personal communication). Habit was considered only as plants occur in Illinois; for example, native populations of *Juniperus communis* are always shrubs in Illinois, and this is the way the species is listed in Table 2, even though the species can become a tree in New England. Four species of *Smilax* (Liliaceae) are

included in this tabulation. Technically, monocots do not produce wood, but superficially these species of *Smilax* are lianas.

Numerous interspecific hybrids that have been given binomial names were added, largely following Mohlenbrock (1986). Common names come from a variety of sources: Iverson *et al.* (1989), Mohlenbrock (1986), Swink and Wilhelm (1979), Little (1979), and Hightshoe (1987). Species included here not in Iverson *et al.* (1989) are: *Rubus pubescens* and *Vaccinium oxycoccus*. Species included in Iverson *et al.* (1989) but excluded here are: *Gossypium hirsutum* (not woody when adventive in Illinois), *Hypericum densiflorum* (occurrence in Illinois doubtful, see Bowles *et al.* 1991), and *Rubus avipes* (placed in synonymy with *R. pensilvanicus* following Gleason and Cronquist, 1991)). Nomenclature follows Mohlenbrock (1986), except when an endangered or threatened species is listed under a different name (Illinois Endangered Species Protection Board, 1994; Herkert and Kruse, 1992).

RESULTS AND DISCUSSION

Some interesting observations can be made based on this list; only species--not varieties and hybrids--were used in compiling the summary information given below and in Table 1. There are a total of 314 species of woody plants native to Illinois, representing 56 families and 113 genera (Table 1). There are 167 species of trees, 166 species of shrubs, and 31 species of lianas or woody vines (some species belong to more than one habit category). Classified as a shrub in these tabulations, *Phoradendron serotinum* is a photosynthetic parasite that grows epiphytically on a number of different host tree species. By far the largest plant family represented by woody plants is the Rosaceae (rose family), with 74 species in 11 genera. Even among trees, the Rosaceae is twice as large with 44 native tree species, compared with the second largest family of trees, the Fagaceae with 22 species. Of the 44 species of tree Rosaceae, 28 belong to *Crataegus*; Mohlenbrock's treatment of this genus (1986), followed here, is very conservative, considering the number of apomictic variants. The same is also true of *Rubus*, with 16 native species recognized. The Rosaceae is also the largest family of trees in the continental United States (Little, 1979), with 77 species in 12 genera (Table 1).

In Illinois, two families have 22 species of woody plants, Fagaceae and Salicaceae; the former all trees, while the latter is about evenly divided between trees and shrubs. The forth largest woody family in the state, Caprifoliaceae, is largely composed of shrubs, with only three species becoming small trees and two species of *Lonicera* being vines. Somewhat surprisingly, the Ericaceae, a family largely restricted to acid habitats, is the fifth (second in numbers of genera) largest woody family in Illinois, with 16 species of shrubs in eight genera. The variety of sandstone habitats in Illinois, along with the few remaining acidic bogs in the northeastern part of the state, provide habitat for the members of the Ericaceae.

There are 47 endangered and 9 threatened species of woody plants in Illinois (Illinois Species Protection Board, 1994; Herkert and Kruse, 1992; Herkert, personal communication). Several species are thought to perhaps be extirpated from Illinois. These include: *Castanea dentata, Linnaea borealis, Andromeda polifolia,* and *Vaccinium stramineum.* The first has been decimated by chestnut blight, a fungal disease introduced from Europe. Habitat destruction is the probable cause for the demise of *Linnaea borealis* and *Andromeda polifolia*. *Vaccinium stramineum* has been recorded from only one site, in Pope County, and recent attempts to relocate the species have been unsuccessful, even though the original habitat is extant (Bowles *et al.*, 1991).

The total number of non-native woody species that have been introduced from other geographic regions and naturalized in Illinois is 126. There are 70 species of adventive shrubs, 10 adventive lianas, and 57 adventive trees. In addition, seven hybrids are reported to be naturalized, five of which are bush honeysuckles (*Lonicera*). Some of these introduced species are local and probably ephemeral, while others have invaded natural communities, displacing native species (see Schwegman, this issue). Some examples include *Lonicera japonica, Pueraria lobata,* the different species and hybrids of bush honeysuckles (*Lonicera*), *Rhamnus cathartica, R. frangula, Viburnum opulus, Berberis thunbergii, Morus alba, Rosa multiflora*, and *Elaeagnus umbellata.* Other species readily spread into disturbed habitats; examples include: *Ailanthus altissima, Albizia julibrissin* (in southern Illinois), and *Ulmus pumila. Robinia pseudoacacia*, native to southern Illinois, has

spread widely beyond its original range.

A number of interspecific hybrids are known to occur naturally in Illinois. Some 25 of these hybrids have been given specific ephitets, and these are listed in Table 2. These include: *Aesculus* x *mississippiensis* (*A. pavia* x *A. glabra*), *Betula* x *purpusii* and *B.*x *sandbergii* (both reputed to be *B. alleghaniensis* x *B. pumila* var. *glandulifera*), *Carya* x *lecontei* (*C. aquatica* x *C. illinoensis*), *Carya nussbaumeri* (*C. illinoensis* x *C. laciniosa*), *Carya* x *schneckii* (*C. tomentosa* x *C. illinoensis*), *Populus* x *smithii* (*P. grandidentata* x *P. tremuloides*), *Salix* x *myricoides* (*S. rigida* x *S. sericea*), *Salix* x *subsericea* (*S. petiolaris* x *S. sericea*), and 18 different interspecific hybrids of *Quercus*.

In the most recent compendium of the trees of the United States (Little, 1979), a total of 679 species of trees are reported to be native to the continental United States. Since slightly different specific, generic, and familiar concepts were used by Little and in Table 2 of the present paper (*Crataegus* is, however, treated conservatively in both), only general comparisons should be made. About 25% (167 of 679) tree species native to the continental United States occur naturally in Illinois. As noted above, the Rosaceae has the most number of tree species in both Illinois and the continental United States. The Fagaceae, tied for second with the Salicaceae in Illinois, is clearly the second largest family nationally. One striking difference with the national list is the dearth of gymnosperms in Illinois, with only 11 native species, of which seven are listed as state endangered or threatened. Tree conifers make up only 6% of the trees in Illinois, while they constitute 14% of the tree species in the continental United States.

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Table 1. Summary data by plant family for the native woody plants of Illinois and comparisons with the native trees of the continental United States. Illinois data based on Appendix iii of Iverson et al. (1989); only species — not subspecies, varieties, or hybrids — were used in this tabulation. Species that can be either a tree/shrub or a shrub/liana are counted in both columns. The information on U. S. trees is from Little (1979); only general comparisons should be made between U. S. and Illinois trees since the two sources have slightly different familial, generic, and specific concepts. The first number in the columns is the number of native species while the number after the slash is the number of genera.

	Illinois Woody Plants	Illinois Shrubs	Illinois Lianas	Illinois Trees	Unites States Trees
Families	56	35	13	31	73
Genera	113	62	18	54	216
Species	314	166	31	167	679
Endangered	47	28	3	18	not available
Threatened	8	4	0	4	not available
Extirpated	4	3	0	1	not available
Rosaceae	74/ 11	52 / 8	0	44 / 5	77 / 12
Fagaceae	22 / 3	0	0	22 / 3	65 / 5
Salicaceae	22 / 2	12 / 1	0	13 / 2	35 / 2
Caprifoliaceae	19 / 6	17 / 6	2 / 1	3 / 1	11 / 2
Ericaceae	16 / 8	16 / 8	0	0	14 / 8
Juglandaceae	12 / 2	0	0	12 / 2	17 / 2
Betulaceae	11 / 5	5 / 3	0	7 / 4	20 / 5
Fabaceae	10 / 7	4 / 2	1 / 1	6 / 5	44 / 19
Vitaceae	10 / 3	0	10 / 3	0	0
Cornaceae	9 / 1	7 / 1	0	3 / 1	11 / 1
Ulmaceae	8 / 3	1 / 1	0	8 / 3	14 / 4
Aceraceae	6 / 1	0	0	6 / 1	13 / 1
Anacardiaceae	6 / 2	6 / 2	1 / 1	3 / 1	15 / 5
Oleaceae	6 / 2	1 / 1	0	6 / 2	22 / 4
Rhamnaceae	6 / 3	5 / 2	1 / 1	1 / 1	15 / 7
Hypericaceae	5 / 2	5 / 2	0	0	1 / 1
Pinaceae	5 / 2	0	0	5 / 2	61 / 6
Celastraceae	4 / 2	3 / 1	1 / 1	0	7 / 6
Cupressaceae	4 / 2	3 / 1	0	3 / 2	26 / 5
Grossulariaceae	4 / 1	4 / 1	0	0	0
Liliaceae	4 / 1	0	4 / 1	0	12 / 2
Aquifoliaceae	3 / 2	3 / 2	0	2 / 1	14 / 2
Bignoniaceae	3 / 3	0	2 / 2	1 / 1	5 / 4
Hippocastanaceae	3 / 1	2 / 1	0	2 / 1	6 / 1
Menispermaceae	3 / 1	0	3 / 1	0	0
Stryacaceae	3 / 2	2 / 1	0	1 / 1	6 / 2
Hamamelidaceae	2 / 2	1 / 1	0	2 / 2	2 / 2
Lauraceae	2 / 2	1 / 1	0	1 / 1	5 / 5
Magnoliaceae	2 / 2	0	0	2 / 2	11 / 3
Nyssaceae	2 / 1	0	0	2 / 1	3 / 1
Ranunculaceae	2 / 1	0	2 / 1	0	0

(Table 1 continued)

	Illinois Woody Plants	Illinois Shrubs	Illinois Lianas	Illinois Trees	Unites States Trees
Rutaceae	2 / 1	2 / 1	0	1 / 1	12 / 5
Sapotaceae	2 / 1	2 / 1	0	2 / 1	8 / 5
Tiliaceae	2 / 1	0	0	2 / 1	3 / 1
Anonaceae	1 / 1	0	0	1 / 1	4 / 2
Apocynaceae	1 / 1	0	1 / 1	0	0
Araliaceae	1 / 1	1 / 1	0	1 / 1	1 / 1
Aristolochiaceae	1 / 1	0	1 / 1	0	0
Berberidaceae	1 / 1	1 / 1	0	0	0
Cistaceae	1 / 1	1 / 1	0	0	0
Ebenaceae	1 / 1	0	0	1 / 1	2 / 1
Elaeagnaceae	1 / 1	1 / 1	0	0	1 / 1
Escalloniaceae	1 / 1	1 / 1	0	0	0
Hydrangeaceae	1 / 1	1 / 1	0	0	0
Moraceae	1 / 1	0	0	1 / 1	5 / 3
Myricaceae	1 / 1	1 / 1	0	0	5 / 1
Philadelphaceae	1 / 1	1 / 1	0	0	0
Platanaceae	1 / 1	0	0	1 / 1	3 / 1
Polygonaceae	1 / 1	0	1 / 1	0	2 / 1
Rubiaceae	1 / 1	1 / 1	0	0	7 / 6
Staphyleaceae	1 / 1	1 / 1	0	1 / 1	2 / 1
Taxaceae	1 / 1	1 / 1	0	0	4 / 2
Taxodiaceae	1 / 1	0	0	1 / 1	4 / 3
Thymelaeaceae	1 / 1	1 / 1	0	0	0
Viscaceae	1 / 1	1 / 1	0	0	0

Table 2. List of trees, shrubs, and woody vines native or naturalized in Illinois. Arranged alphabetically by genus and species. Based primarily on Iverson et al. (1989, Appendix iii) with some modifications and additions, especially with regards to interspecific hybrids and subspecific taxa. Nomenclature, including family names, follows Mohlenbrock (1986) except when the official list of endangered and threatened species uses a different name (Illinois Endangered Species Protection Board, 1994; Herkert & Kruse, 1992; Herkert, personal communication). Habit applies only to Illinois, i.e., some species that are always shrubs in Illinois may become trees elsewhere. Only one common name is given for each species; these come from various sources: Iverson et al. (1989), Little (1979), Mohlenbrock (1986), and Hightshoe (1987). Botanical forms are not included. The following abbreviations are used below. Column 3: T = tree, S = shrub, L = liana. Column 4: N = native, I = introduced. Column 5: E = endangered in Illinois, T = threatened in Illinois, X = presumed extirpated from the wild in Illinois.

Scientific name	Family	Habit	Native	E/T	Common name
Acer floridanum	Aceraceae	T	N		Southern sugar maple
Acer ginnala	Aceraceae	T/S	I		Amur maple
Acer negundo	Aceraceae	T	N		Boxelder
Acer nigrum	Aceraceae	T	N		Black maple
Acer platanoides	Aceraceae	T	I		Norway maple
Acer pseudoplatanus	Aceraceae	T	I		Sycamore maple
Acer rubrum var. *drummondii*	Aceraceae	T	N		Drummond's red maple
Acer rubrum var. *rubrum*	Aceraceae	T	N		Red maple
Acer rubrum var. *trilobum*	Aceraceae	T	N		Red maple
Acer saccharinum	Aceraceae	T	N		Silver maple
Acer saccharum var. *saccharum*	Aceraceae	T	N		Sugar maple
Acer saccharum var. *schneckii*	Aceraceae	T	N		Schneck's sugar maple
Aesculus flava	Hippocastanaceae	T/S	N		Yellow buckeye
Aesculus glabra var. *glabra*	Hippocastanaceae	T	N		Ohio buckeye
Aesculus glabra var. *leucodermis*	Hippocastanaceae	T	N		Ohio buckeye
Aesculus hippocastanum	Hippocastanaceae	T	I		Horse chestnut
Aesculus pavia	Hippocastanaceae	T/S	N		Red buckeye
Aesculus × *mississippiensis*	Hippocastanaceae	T/S	N		Hybrid buckeye
Ailanthus altissima	Simaroubaceae	T	I		Tree-of-heaven
Albizia julibrissin	Fabaceae	T	I		Mimosa-tree
Alnus glutinosa	Betulaceae	T	I		Black alder
Alnus rugosa	Betulaceae	S	N	E	Speckled alder
Alnus serrulata	Betulaceae	T/S	N		Common alder
Amelanchier arborea	Rosaceae	T/S	N		Downy serviceberry
Amelanchier humilis	Rosaceae	S	N		Low shadbush
Amelanchier interior	Rosaceae	T	N	E	Inland serviceberry
Amelanchier laevis	Rosaceae	S	N		Allegheny serviceberry
Amelanchier sanguinea	Rosaceae	T/S	N	E	Round-leaved serviceberry
Amorpha canescens	Fabaceae	S	N		Lead plant
Amorpha fruticosa var. *angustifolia*	Fabaceae	S	N		False indigo
Amorpha fruticosa var. *croceolanata*	Fabaceae	S	N		False indigo
Amorpha fruticosa var. *fruticosa*	Fabaceae	S	N		False indigo
Amorpha nitens	Fabaceae	S	N	E	Smooth false indigo
Ampelopsis arborea	Vitaceae	L	N		Pepper vine
Ampelopsis cordata	Vitaceae	L	N		Raccoon grape

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Andromeda polifolia var. *glaucophylla*	Ericaceae	S	N	X	Bog rosemary
Aralia elata	Araliaceae	T/S	I		Japanese angelica tree
Aralia spinosa	Araliaceae	T/S	N		Devil's walking stick
Arctostaphylos uva-ursi subsp. *coactilis*	Ericaceae	S	N	E	Bearberry
Aristolochia tomentosa	Aristolochiaceae	L	N		Dutchman's pipe
Aronia melanocarpa	Rosaceae	S	N		Black chokeberry
Aronia prunifolia	Rosaceae	S	N		Purple chokeberry
Artemisia abrotanum	Asteraceae	S	I		Garden sagebrush
Artemisia absinthium	Asteraceae	S	I		Absinthe
Artemisia frigida	Asteraceae	S	I		Fringed sagebrush
Artemisia pontica	Asteraceae	S	I		Roman wormwood
Asimina triloba	Annonaceae	T	N		Pawpaw
Berberis canadensis	Berberidaceae	S	N	E	Allegheny barberry
Berberis thunbergii	Berberidaceae	S	I		Japanese barberry
Berberis vulgaris	Berberidaceae	S	I		Common barberry
Berchemia scandens	Rhamnaceae	L	N	E	Supple-jack
Betula alleghaniensis	Betulaceae	T	N	E	Yellow birch
Betula nigra	Betulaceae	T	N		River birch
Betula papyrifera	Betulaceae	T	N		Paper birch
Betula populifolia	Betulaceae	T	N	E	Gray birch
Betula pumila var. *glabra*	Betulaceae	S	N		Dwarf birch
Betula pumila var. *glandulifera*	Betulaceae	S	N		Dwarf birch
Betula pumila var. *pumila*	Betulaceae	S	N		Dwarf birch
Betula × *purpusii*	Betulaceae	T/S	N		Purpus' birch
Betula × *sandbergii*	Betulaceae	T/S	N		Sandberg's birch
Bignonia capreolata	Bignoniaceae	L	N		Cross vine
Broussonetia papyrifera	Moraceae	T	I		Paper mulberry
Brunnichia ovata	Polygonaceae	L	N		Buckwheat vine
Bumelia lanuginosa var. *oblongifolia*	Sapotaceae	T/S	N	E	Chittam wood
Bumelia lycioides	Sapotaceae	T/S	N		Southern buckthorn
Calycanthus floridus	Calycanthaceae	S	I		Strawberry shrub
Calycocarpum lyonii	Menispermaceae	L	N		Cupseed
Campsis radicans	Bignoniaceae	L	N		Trumpet creeper
Caragana arborescens	Fabaceae	T/S	I		Siberian pea-tree
Carpinus caroliniana	Betulaceae	T	N		American hornbeam
Carya aquatica	Juglandaceae	T	N		Water hickory
Carya cordiformis	Juglandaceae	T	N		Bitternut hickory
Carya glabra var. *megacarpa*	Juglandaceae	T	N		Pignut hickort
Carya illinoensis	Juglandaceae	T	N		Pecan
Carya laciniosa	Juglandaceae	T	N		Shellbark hickory
Carya ovalis var. *obovalis*	Juglandaceae	T	N		Sweet pignut hickory
Carya ovalis var. *odorata*	Juglandaceae	T	N		Sweet pignut hickory
Carya ovalis var. *ovalis*	Juglandaceae	T	N		Sweet pignut hickory
Carya ovata var. *fraxinifolia*	Juglandaceae	T	N		Ash-leaved shagbark hickory

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Carya ovata var. *nuttallii*	Juglandaceae	T	N		Small shagbark hickory
Carya ovata var. *ovata*	Juglandaceae	T	N		Shagbark hickory
Carya pallida	Juglandaceae	T	N	E	Pale hickory
Carya texana	Juglandaceae	T	N		Black hickory
Carya tomentosa	Juglandaceae	T	N		Mockernut hickory
Carya × *lecontei*	Juglandaceae	T	N		Hickory
Carya × *nussbaumeri*	Juglandaceae	T	N		Hickory
Carya × *schneckii*	Juglandaceae	T	N		Hickory
Castanea dentata	Fagaceae	T	N	X	American chestnut
Castanea mollissima	Fagaceae	T	I		Chinese chestnut
Catalpa bignonioides	Bignoniaceae	T	I		Common catalpa
Catalpa speciosa	Bignoniaceae	T	N		Western catalpa
Ceanothus americanus var. *americanus*	Rhamnaceae	S	N		New Jersey tea
Ceanothus americanus var. *pitcheri*	Rhamnaceae	S	N		New Jersey tea
Ceanothus ovatus	Rhamnaceae	S	N	E	Redroot
Celastrus orbicularis	Celastraceae	L	I		Round-leaved bittersweet
Celastrus scandens	Celastraceae	L	N		American bittersweet
Celtis laevigata var. *laevigata*	Ulmaceae	T	N		Sugarberry
Celtis laevigata var. *smallii*	Ulmaceae	T	N		Toothed sugarberry
Celtis laevigata var. *texana*	Ulmaceae	T	N		Cliff sugarberry
Celtis occidentalis var. *canina*	Ulmaceae	T	N		Hackberry
Celtis occidentalis var. *occidentalis*	Ulmaceae	T	N		Hackberry
Celtis occidentalis var. *pumila*	Ulmaceae	T	N		Small hackberry
Celtis tenuifolia var. *georgiana*	Ulmaceae	T/S	N		Dwarf hackberry
Celtis tenuifolia var. *tenuifolia*	Ulmaceae	T/S	N		Dwarf hackberry
Cephalanthus occidentalis var. *occidentalis*	Rubiaceae	S	N		Buttonbush
Cephalanthus occidentalis var. *pubescens*	Rubiaceae	S	N		Buttonbush
Cercis canadensis	Fabaceae	T/S	N		Redbud
Chaenomeles japonica	Rosaceae	S	I		Japanese quince
Chamaedaphne calyculata var. *angustifolia*	Ericaceae	S	N	T	Leatherleaf
Cladrastis lutea	Fabaceae	T	N	E	Yellowwood
Clematis occidentalis	Ranunculaceae	L	N	E	Purple clematis
Clematis virginiana	Ranunculaceae	L	N		Virgin's bower
Cocculus carolinus	Menispermaceae	L	N		Snailseed
Comptonia peregrina	Myricaceae	S	N	E	Sweetfern
Cornus alternifolia	Cornaceae	T	N		Pogoda dogwood
Cornus amomum	Cornaceae	S	N		Silky dogwood
Cornus drummondii	Cornaceae	T/S	N		Rough-leaved dogwood
Cornus florida	Cornaceae	T	N		flowering dogwood
Cornus foemina	Cornaceae	S	N		Stiff dogwood
Cornus obliqua	Cornaceae	S	N		Pale dogwood

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Cornus racemosa	Cornaceae	S	N		Gray dogwood
Cornus rugosa	Cornaceae	S	N		Round-leaved dogwood
Cornus stolonifera var. *baileyi*	Cornaceae	S	N		Bailey's dogwood
Cornus stolonifera var. *stolonifera*	Cornaceae	S	N		Red osier dogwood
Corylus americana	Betulaceae	S	N		Hazelnut
Corylus cornuta	Betulaceae	S	N	E	Beaked hazelnut
Crataegus acutifolia	Rosaceae	T	N		Hawthorn
Crataegus calpodendron	Rosaceae	T/S	N		Urn-shaped hawthorn
Crataegus coccinioides	Rosaceae	T/S	N		Hawthorn
Crataegus collina	Rosaceae	T	N		Hawthorn
Crataegus corusca	Rosaceae	T	N		Hawthorn
Crataegus crus-galli var. *barrettiana*	Rosaceae	T/S	N		Barrett's hawthorn
Crataegus crus-galli var. *crus-galli*	Rosaceae	T/S	N		Cock-spur hawthorn
Crataegus cuneiformis	Rosaceae	T	N		Hawthorn
Crataegus engelmanii	Rosaceae	T/S	N		Barberry-leaved hawthorn
Crataegus faxonii	Rosaceae	T/S	N		Hawthorn
Crataegus fecunda	Rosaceae	T	N		Fruitful hawthorn
Crataegus hannibalensis	Rosaceae	T/S	N		Hawthorn
Crataegus holmesiana	Rosaceae	T/S	N		Hawthorn
Crataegus lucorum	Rosaceae	T/S	N		Hawthorn
Crataegus macrosperma	Rosaceae	T/S	N		Hawthorn
Crataegus margaretta	Rosaceae	T/S	N		Hawthorn
Crataegus marshalii	Rosaceae	T/S	N		Parsley hawthorn
Crataegus mollis	Rosaceae	T	N		Red haw
Crataegus monogyna	Rosaceae	T/S	I		English hawthorn
Crataegus neobushii	Rosaceae	T	N		Hawthorn
Crataegus nitida	Rosaceae	T	N		Glossy hawthorn
Crataegus pedicellata	Rosaceae	T/S	N		Hawthorn
Crataegus permixta	Rosaceae	T	N		Hawthorn
Crataegus phaenopyrum	Rosaceae	T	N		Washington hawthorn
Crataegus pringlei	Rosaceae	T	N		Hawthorn
Crataegus pruinosa	Rosaceae	T/S	N		Frosted hawthorn
Crataegus punctata	Rosaceae	T/S	N		Dotted hawthorn
Crataegus succulenta	Rosaceae	T/S	N		fleshy hawthorn
Crataegus tortilis	Rosaceae	T/S	N		Hawthorn
Crataegus viridis	Rosaceae	T	N		Green hawthorn
Cydonia oblonga	Rosaceae	T/S	I		Quince
Deutzia scabra	Philadelphaceae	S	I		Pride-of-Rochester
Diervilla lonicera	Caprifoliaceae	S	N		Bush honeysuckle
Diospyros virginiana	Ebenaceae	T	N		Permisson
Dirca palustris	Thymelaeaceae	S	N		Leatherwood
Elaeagnus angustifolia	Elaeagnaceae	T/S	I		Russian olive
Elaeagnus multiflora	Elaeagnaceae	S	I		Oleastern
Elaeagnus umbellata	Elaeagnaceae	S	I		Autumn olive

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Epigaea repens	Ericaceae	S	N		Trailing arbutus
Euonymus alatus	Celastraceae	S	I		Burning bush
Euonymus americanus	Celastraceae	S	N	E	Strawberry bush
Euonymus atropurpureus	Celastraceae	S	N		Eastern wahoo
Euonymus euopaeus	Celastraceae	S	I		European spindle-tree
Euonymus fortunei	Celastraceae	S	I		Wintercreeper
Euonymus kiautschovicus	Celastraceae	S	I		Spreading euonyumus
Euonymus obovatus	Celastraceae	S	N		Running strawberry bush
Fagus grandifolia var. *caroliniana*	Fagaceae	T	N		American beech
Forestiera acuminata	Oleaceae	T/S	N		Swamp privet
Fraxinus americana	Oleaceae	T	N		White ash
Fraxinus nigra	Oleaceae	T	N		Black ash
Fraxinus pennsylvanica	Oleaceae	T	N		Green ash
Fraxinus profunda	Oleaceae	T	N		Pumpkin ash
Fraxinus quadrangulata	Oleaceae	T	N		Blue ash
Gaultheria procumbens	Ericaceae	S	N	E	Wintergreen
Gaylussacia baccata	Ericaceae	S	N		Black huckleberry
Gleditsia aquatica	Fabaceae	T	N		Water locust
Gleditsia triacanthos	Fabaceae	T	N		Honeylocust
Gymnocladus dioica	Fabaceae	T	N		Kentucky coffee tree
Halesia carolina	Styracaceae	T	N	E	Carolina silverbell
Hamamelis virginiana	Hamamelidaceae	T/S	N		Common witch-hazel
Hedera helix	Araliaceae	L	I		English ivy
Hibiscus syriacus	Malvaceae	S	I		Rose-of-Sharon
Hudsonia tomentosa var. *intermedia*	Cistaceae	S	N	E	Beach heather
Hudsonia tomentosa var. *tomentosa*	Cistaceae	S	N	E	Beach heather
Hydrangea arborescens	Hydrangeaceae	S	N		Smooth hydrangea
Hypericum hypericoides	Hypericaceae	S	N		St. Andrew's cross
Hypericum kalmianum	Hypericaceae	S	N	E	Kalm St. John's-wort
Hypericum lobocarpum	Hypericaceae	S	N		St. John's-wort
Hypericum prolificum	Hypericaceae	S	N		Shrubby St. John's-wort
Hypericum stragulum	Hypericaceae	S	N		St. Andrew's cross
Ilex decidua	Aquifoliaceae	T/S	N		Possom haw
Ilex verticillata	Aquifoliaceae	T/S	N		American holly
Itea virginica	Escalloniaceae	S	N		Virginia sweetspire
Juglans cinerea	Juglandaceae	T	N		Butternut
Juglans nigra	Juglandaceae	T	N		Black walnut
Juniperus communis var. *communis*	Cupressaceae	S	N	T	Common juniper
Juniperus communis var. *depress*	Cupressaceae	S	N	T	Ground juniper
Juniperus horizontalis	Cupressaceae	S	N	E	Trailing juniper
Juniperus virginiana	Cupressaceae	T	N		Eastern redcedar
Kerria japonica	Rosaceae	S	I		Japanese kerria
Koelreuteria paniculata	Sapindaceae	T	I		Goldenrain tree
Larix decidua	Pinaceae	T	I		European larch

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Larix laricina	Pinaceae	T	N	T	Tamarack
Ligustrum obtusifolium	Oleaceae	S	I		Border privet
Ligustrum vulgare	Oleaceae	S	I		Common privet
Lindera benzoin var. *benzoin*	Lauraceae	S	N		Spicebush
Lindera benzoin var. *pubescens*	Lauraceae	S	N		Hairy spicebush
Linnaea borealis subsp. *americana*	Caprifoliaceae	S	N	X	Twinflower
Liquidambar styraciflua	Hamamelidaceae	T	N		Sweetgum
Liriodendron tulipifera	Magnoliaceae	T	N		Tulip tree
Lonicera dioica var. *dioica*	Caprifoliaceae	S/L	N		Red honeysuckle
Lonicera dioica var. *glaucescens*	Caprifoliaceae	S/L	N	E	Red honeysuckle
Lonicera flava	Caprifoliaceae	L	N	E	Yellow honeysuckle
Lonicera japonica var. *chinensis*	Caprifoliaceae	L	I		Japanese honeysuckle
Lonicera japonica var. *japonica*	Caprifoliaceae	L	I		Japanese honeysuckle
Lonicera maackii	Caprifoliaceae	S	I		Amur honeysuckle
Lonicera morrowii	Caprifoliaceae	S	I		Morrow honeysuckle
Lonicera prolifera	Caprifoliaceae	L	N		Grape honeysuckle
Lonicera ruprechtiana	Caprifoliaceae	S	I		Manchurian honeysuckle
Lonicera sempervirens	Caprifoliaceae	L	I		Trumpet honeysuckle
Lonicera standishii	Caprifoliaceae	S	I		Honeysuckle
Lonicera tatartica	Caprifoliaceae	S	I		Tatarian honeysuckle
Lonicera × *bella*	Caprifoliaceae	S	I		Belle honeysuckle
Lonicera × *minutiflora*	Caprifoliaceae	S	I		Bush Honeysuckle
Lonicera × *muendeniensis*	Caprifoliaceae	S	I		Bush honeysuckle
Lonicera × *muscaviensis*	Caprifoliaceae	S	I		Bush honeysuckle
Lonicera × *xylosteoides*	Caprifoliaceae	S	I		Bush honeysuckle
Lonicera xylosteum	Caprifoliaceae	S	I		European fly honeysuckle
Lycium barbarum	Solanaceae	S	I		Common matrimony vine
Lycium chinense	Solanaceae	S	I		Chinese matrimony vine
Maclura pomifera	Moraceae	T	I		Osage orange
Magnolia acuminata	Magnoliaceae	T	N		Cucumber magnolia
Malus angustifolia	Rosaceae	T	N	E	Southern crab apple
Malus coronaria var. *coronaria*	Rosaceae	T	N		Sweet crab apple
Malus coronaria var. *dasycalyx*	Rosaceae	T	N		Sweet crab apple
Malus ioensis	Rosaceae	T	N		Prairie crab apple
Malus pumila	Rosaceae	T	I		Apple
Malus × *soulardii*	Rosaceae	T	I		Soulard crab apple
Menispermum canadensis	Menispermaceae	L	N		Moonseed
Morus alba var. *alba*	Moraceae	T/S	I		White mulberry
Morus alba var. *tatarica*	Moraceae	T/S	I		Russian mulberry
Morus rubra	Moraceae	T	N		Red mulberry
Nemopanthus mucronatus	Aquifoliaceae	S	N		Mountain holly
Nyssa aquatica	Nyssaceae	T	N		Water tupelo
Nyssa sylvatica var. *caroliniana*	Nyssaceae	T	N		Black tupelo
Nyssa sylvatica var. *sylvatica*	Nyssaceae	T	N		Black tupelo

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Onosis spinosa	Fabaceae	S	I		Rest-harrow
Ostrya virginiana	Betulaceae	T	N		Hop hornbeam
Oxydendrum arboreum	Ericaceae	T	I		Sourwood
Parthenocissus inserta	Vitaceae	L	N		Virginia creeper
Parthenocissus quinquefolia	Vitaceae	L	N		Virginia creeper
Parthenocissus tricuspidata	Vitaceae	L	I		Boston ivy
Paulownia tomentosa	Scrophulariaceae	T	I		Royal paulownia
Philadelphus coronarius	Philadelphaceae	S	I		Sweet mock-orange
Philadelphus inodorus	Philadelphaceae	S	I		Scentless mock-orange
Philadelphus pubescens	Philadelphaceae	S	N		Mock-orange
Phoradendron serotinum	Viscaceae	S	N		Mistletoe
Physocarpus opulifolius	Rosaceae	S	N		Common ninebark
Picea abies	Pinaceae	T	I		Norway spruce
Picea mariana	Pinaceae	T	I		Black spruce
Pinus banksiana	Pinaceae	T	N	E	Jack pine
Pinus echinata	Pinaceae	T	N	E	Shortleaf pine
Pinus nigra	Pinaceae	T	I		Austrian pine
Pinus pungens	Pinaceae	T	I		Prickly pine
Pinus resinosa	Pinaceae	T	N	E	Red pine
Pinus rigida	Pinaceae	T	I		Pitch pine
Pinus strobus	Pinaceae	T	N		White pine
Pinus sylvestris	Pinaceae	T	I		Scotch pine
Pinus taeda	Pinaceae	T	I		Loblolly pine
Pinus wallichiana	Pinaceae	T	I		Himalayan pine
Planera aquatica	Ulmaceae	T	N	E	Water elm
Platanus occidentalis	Platanaceae	T	N		Sycamore
Populus alba	Salicaceae	T	I		White poplar
Populus balsamifera	Salicaceae	T	N	E	Balsam poplar
Populus deltoides	Salicaceae	T	N		Eastern cottonwood
Populus grandidentata	Salicaceae	T	N		Big-toothed aspen
Populus heterophylla	Salicaceae	T	N		Swamp cottonwood
Populus nigra var. *italica*	Salicaceae	T	I		Lombardy poplar
Populus tremuloides	Salicaceae	T	N		Quaking aspen
Populus × *canescens*	Salicaceae	T	I		Gray poplar
Populus × *gileadensis*	Salicaceae	T	I		Balm-of-Gilead
Populus × *smithii*	Salicaceae	T	N		Barnes' aspen
Potentilla fruticosa subsp. *floribunda*	Rosaceae	S	N		Bush cinquefoil
Prunus americana var. *americana*	Rosaceae	T/S	N		American plum
Prunus americana var. *lanata*	Rosaceae	T/S	N		American plum
Prunus angustifolia	Rosaceae	T/S	N		Chickasaw plum
Prunus armeniaca	Rosaceae	T	I		Apricot
Prunus avium	Rosaceae	T	I		Sweet cherry
Prunus cerasus	Rosaceae	T	I		Sour cherry
Prunus hortulana	Rosaceae	T	N		Wild goose plum

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Prunus mahaleb	Rosaceae	T/S	I		Mahaleb cherry
Prunus mexicana	Rosaceae	T	N		Mexican plum
Prunus munsoniana	Rosaceae	T	N		Wild goose plum
Prunus nigra	Rosaceae	T	N		Canadian plum
Prunus padus	Rosaceae	T/S	I		European bird cherry
Prunus pensylvanica	Rosaceae	T/S	N		Pin cherry
Prunus persica	Rosaceae	T	I		Peach
Prunus serotina	Rosaceae	T	N		Black cherry
Prunus susquehanae	Rosaceae	S	N		Sand cherry
Prunus triloba	Rosaceae	T/S	I		flowering almond
Prunus virginiana	Rosaceae	T/S	N		Choke cherry
Ptelea trifoliata	Rutaceae	T/S	N		Wafer ash
Pueraria lobata	Fabaceae	L	I		Kudzu-vine
Pyrus calleryana	Rosaceae	T	I		Callery pear
Pyrus communis	Rosaceae	T	I		Common pear
Pyrus pyrifolia	Rosaceae	T	I		Chinese pear
Quercus alba	Fagaceae	T	N		White oak
Quercus bicolor	Fagaceae	T	N		Swamp white oak
Quercus coccinea	Fagaceae	T	N		Scarlet oak
Quercus ellipsoidalis	Fagaceae	T	N		Hill's oak
Quercus falcata	Fagaceae	T	N		Southern red oak
Quercus imbricaria	Fagaceae	T	N		Laurel oak
Quercus lyrata	Fagaceae	T	N		Overcup oak
Quercus macrocarpa	Fagaceae	T	N		Bur oak
Quercus marilandica	Fagaceae	T	N		Blackjack oak
Quercus michauxii	Fagaceae	T	N		Swamp chestnut oak
Quercus nuttallii	Fagaceae	T	N	E	Nuttall's oak
Quercus pagoda	Fagaceae	T	N		Cherrybark oak
Quercus palustris	Fagaceae	T	N		Pin oak
Quercus phellos	Fagaceae	T	N	T	Willow oak
Quercus prinoides var. *acuminata*	Fagaceae	T	N		Chinkapin oak
Quercus prinus	Fagaceae	T	N	T	Chestnut oak
Quercus rubra	Fagaceae	T	N		Northern red oak
Quercus shumardii	Fagaceae	T	N		Shumard's oak
Quercus stellata	Fagaceae	T	N		Post oak
Quercus velutina	Fagaceae	T	N		Black oak
Quercus × *anceps*	Fagaceae	T	N		Hybrid oak
Quercus × *bebbiana*	Fagaceae	T	N		Hybrid oak
Quercus × *bushii*	Fagaceae	T	N		Hybrid oak
Quercus × *deamii*	Fagaceae	T	N		Hybrid oak
Quercus × *exacta*	Fagaceae	T	N		Hybrid oak
Quercus × *fallax*	Fagaceae	T	N		Hybrid oak
Quercus × *fernowii*	Fagaceae	T	N		Hybrid oak
Quercus × *filialis*	Fagaceae	T	N		Hybrid oak

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Quercus × hillii	Fagaceae	T	N		Hybrid oak
Quercus × humidicola	Fagaceae	T	N		Hybrid oak
Quercus × jackiana	Fagaceae	T	N		Hybrid oak
Quercus × ludoviciana	Fagaceae	T	N		Hybrid oak
Quercus × palmeriana	Fagaceae	T	N		Hybrid oak
Quercus × runcinata	Fagaceae	T	N		Hybrid oak
Quercus × saulii	Fagaceae	T	N		Hybrid oak
Quercus × schochiana	Fagaceae	T	N		Hybrid oak
Quercus × schuettei	Fagaceae	T	N		Hybrid oak
Quercus × tridentata	Fagaceae	T	N		Hybrid oak
Rehsonia floribunda	Fabaceae	L	I		Japanese wisteria
Rehsonia sinensis	Fabaceae	L	I		Chinese wisteria
Rhamnus alnifolia	Rhamnaceae	S	N	E	Alder buckthorn
Rhamnus caroliniana	Rhamnaceae	T/S	N		Carolina buckthorn
Rhamnus cathartica	Rhamnaceae	T/S	I		Common buckthorn
Rhamnus davurica	Rhamnaceae	T	I		Dahurian buckthorn
Rhamnus frangula var. *angustifolia*	Rhamnaceae	T/S	I		Narrow-leaved glossy buckthorn
Rhamnus frangula var. *frangula*	Rhamnaceae	T/S	I		Glossy buckthorn
Rhamnus lanceolata	Rhamnaceae	S	N		Lance-leaved buckthorn
Rhododendron periclymenoides	Ericaceae	S	N		Pinxter flower
Rhododendron prinophyllum	Ericaceae	S	N		Early azalea
Rhodotypos scandens	Rosaceae	S	I		Jetbead
Rhus aromatica var. *arenaria*	Anacardiaceae	S	N		Beach sumac
Rhus aromatica var. *aromatica*	Anacardiaceae	S	N		Fragrant sumac
Rhus aromatica var. *serotina*	Anacardiaceae	S	N		Fragrant sumac
Rhus copallina	Anacardiaceae	T/S	N		Winged sumac
Rhus glabra	Anacardiaceae	T/S	N		Smooth sumac
Rhus typhina	Anacardiaceae	T/S	N		Staghorn sumac
Ribes americanum	Grossulariaceae	S	N		Wild black current
Ribes cynosbati	Grossulariaceae	S	N		Prickly gooseberry
Ribes hirtellum	Grossulariaceae	S	N	E	Northern gooseberry
Ribes missouriense	Grossulariaceae	S	N		Missouri gooseberry
Ribes nigrum	Grossulariaceae	S	I		Black current
Ribes odoratum	Grossulariaceae	S	I		Buffalo current
Ribes rubrum	Grossulariaceae	S	I		Red current
Robinia hispida	Fabaceae	S	I		Bristly locust
Robinia pseudoacacia	Fabaceae	T	N		Black locust
Robinia viscosa	Fabaceae	T/S	I		Clammy locust
Rosa acicularis	Rosaceae	S	N	E	Prickly rose
Rosa arkansana	Rosaceae	S	I		Lunell's rose
Rosa blanda	Rosaceae	S	N		Meadow rose
Rosa canina	Rosaceae	S	I		Dog rose
Rosa carolina var. *carolina*	Rosaceae	S	N		Pasture rose

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Rosa carolina var. *villosa*	Rosaceae	S	N		Pasture rose
Rosa eglanteria	Rosaceae	S	I		Sweet-brier
Rosa gallica	Rosaceae	S	I		French rose
Rosa micrantha	Rosaceae	S	I		Small sweet-brier
Rosa moschata	Rosaceae	S	I		Musk rose
Rosa multiflora	Rosaceae	S	I		Multiflora rose
Rosa palustris	Rosaceae	S	N		Swamp rose
Rosa rubrifolia	Rosaceae	S	I		Red-leaved rose
Rosa rugosa	Rosaceae	S	I		Rugose rose
Rosa setigera var. *setigera*	Rosaceae	S	N		Prairie rose
Rosa setigera var. *tomentosa*	Rosaceae	S	N		Prairie rose
Rosa spinosissima	Rosaceae	S	I		Scotch rose
Rosa suffulta	Rosaceae	S	N		Sunshine rose
Rosa wichuriana	Rosaceae	S	I		Memorial rose
Rubus allegheniensis	Rosaceae	S	N		Common blackberry
Rubus alumnus	Rosaceae	S	N		Blackberry
Rubus argutus	Rosaceae	S	N		Highbush blackberry
Rubus discolor	Rosaceae	S	I		Himalaya-berry
Rubus enslenii	Rosaceae	S	N		Arching dewberry
Rubus flagellaris	Rosaceae	S	N		Dewberry
Rubus frondosus	Rosaceae	S	N		Blackberry
Rubus hispidus	Rosaceae	S	N		Swamp dewberry
Rubus idaeus	Rosaceae	S	I		European raspberry
Rubus laciniatus	Rosaceae	S	I		Cut-leaved blackberry
Rubus occidentalis	Rosaceae	S	N		Black raspberry
Rubus odoratus	Rosaceae	S	N	E	flowering raspberry
Rubus pensylvanicus	Rosaceae	S	N		Blackberry
Rubus phoenicolasius	Rosaceae	S	I		Wineberry
Rubus pubescens	Rosaceae	S	N	T	Dwarf raspberry
Rubus roribaccus	Rosaceae	S	N		Velvet-leaved dewberry
Rubus setosus	Rosaceae	S	N	E	Bristly blackberry
Rubus strigosus	Rosaceae	S	N		Red raspberry
Rubus trivalis	Rosaceae	S	N		Southern dewberry
Salix alba var. *alba*	Salicaceae	T	I		White willow
Salix alba var. *calva*	Salicaceae	T	I		White willow
Salix alba var. *vitellina*	Salicaceae	T	I		White willow
Salix amygdaloides	Salicaceae	T	N		Peach-leaved willow
Salix babylonica	Salicaceae	T	I		Weeping willow
Salix bebbiana	Salicaceae	T/S	N		Beaked willow
Salix candida	Salicaceae	S	N		Hoary willow
Salix caprea	Salicaceae	T/S	I		Goat willow
Salix caroliniana	Salicaceae	T	N		Carolina willow
Salix discolor	Salicaceae	T	N		Pussy willow
Salix eriocephala	Salicaceae	T	N		Willow

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Salix exigua	Salicaceae	S	N		Sandbar willow
Salix fragilis	Salicaceae	T	I		Crack willow
Salix glaucophylloides var. *glaucophylla*	Salicaceae	S	N		Blue-leaf willow
Salix humilis var. *humilis*	Salicaceae	S	N		Prairie willow
Salix humilis var. *hyporhysa*	Salicaceae	S	N		Prairie willow
Salix humilis var. *microphylla*	Salicaceae	S	N		Sage willow
Salix lucida	Salicaceae	T/S	N		Shinning willow
Salix nigra	Salicaceae	T	N		Black willow
Salix pedicellaris var. *hypoglauca*	Salicaceae	S	N		Bog willow
Salix pentandra	Salicaceae	T/S	I		Laurel willow
Salix petiolaris	Salicaceae	S	N		Meadow willow
Salix purpurea	Salicaceae	S	I		Purple osier
Salix rigida	Salicaceae	S	N		Heart-leaved willow
Salix sericea	Salicaceae	T/S	N		Silky willow
Salix serissima	Salicaceae	S	N	E	Autumn willow
Salix syrticola	Salicaceae	S	N	E	Dune willow
Salix × *nyricoides*	Salicaceae	S	N		Willow
Salix × *subsericea*	Salicaceae	S	N		Willow
Sambucus canadensis	Caprifoliaceae	S	N		Elderberry
Sambucus pubens	Caprifoliaceae	S	N	T	Red-berried elder
Sassafras albidum var. *albidum*	Lauraceae	T	N		Sassafras
Sassafras albidum var. *molle*	Lauraceae	T	N		Red sassafras
Shepherdia canadensis	Elaeagnaceae	S	N	E	Buffalo-berry
Smilax bona-nox var. *bona-nox*	Liliaceae	L	N		Catbrier
Smilax bona-nox var. *hederaefolia*	Liliaceae	L	N		Catbrier
Smilax glauca var. *glauca*	Liliaceae	L	N		Catbrier
Smilax glauca var. *leurophylla*	Liliaceae	L	N		Catbrier
Smilax hispida	Liliaceae	L	N		Bristly greenbrier
Smilax rotundifolia	Liliaceae	L	N		Catbrier
Sorbus americana	Rosaceae	T	N	E	American mountain-ash
Sorbus aucuparia	Rosaceae	T	I		European mountain-ash
Spiraea alba	Rosaceae	S	N		Meadowsweet
Spiraea japonica	Rosaceae	S	I		Japanese spirea
Spiraea latifolia	Rosaceae	S	I		Meadowsweet
Spiraea prunifolia	Rosaceae	S	I		Bridalwreath
Spiraea tomentosa	Rosaceae	S	N		Hardhack
Staphylea trifolia	Staphyleaceae	S/T	N		Bladdernut
Styrax americana	Styracaceae	S	N	T	Storax
Styrax grandifolia	Styracaceae	S	N	E	Bigleaf snowbell bush
Symphoricarpos albus var. *albus*	Caprifoliaceae	S	N	E	Common snowberry
Symphoricarpos albus var. *laevigatus*	Caprifoliaceae	S	I		Common snowberry
Symphoricarpos occidentalis	Caprifoliaceae	S	N		Western snowberry
Symphoricarpos orbiculatus	Caprifoliaceae	S	N		Coralberry
Syringa vulgaris	Oleaceae	S	I		Common lilac

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Tamarix gallica	Tamaricaceae	T/S	I		French tamarisk
Taxodium distichum	Taxodiaceae	T	N		Bald cypress
Taxus canadensis	Taxaceae	S	N		Canada yew
Thuja occidentalis	Cupressaceae	T	N	T	Eastern arborvitae
Thymus praecox	Lamiaceae	S	I		Creeping thyme
Tilia americana var. *americana*	Tiliaceae	T	N		American basswood
Tilia americana var. *neglecta*	Tiliaceae	T	N		American basswood
Tilia heterophylla	Tiliaceae	T	N	E	White basswood
Toxicodendron radicans	Anacardiaceae	S/L	N		Poison ivy
Toxicodendron toxicarum	Anacardiaceae	L	I		Poison oak
Toxicodendron vernix	Anacardiaceae	S	N		Poison sumac
Trachelospermum difforme	Apocynaceae	L	N		Climbing dogbane
Ulmus alata	Ulmaceae	T	N		Winged elm
Ulmus americana	Ulmaceae	T	N		American elm
Ulmus pumila	Ulmaceae	T/S	I		Siberian elm
Ulmus rubra	Ulmaceae	T	N		Slippery elm
Ulmus thomasii	Ulmaceae	T	N	E	Rock elm
Ulmus procera	Ulmaceae	T	I		English elm
Vaccinium angustifolium	Ericaceae	S	N		Low-bush blueberry
Vaccinium arboreum var. *arboreum*	Ericaceae	S	N		Farkleberry
Vaccinium arboreum var. *glaucescens*	Ericaceae	S	N		Farkleberry
Vaccinium corymbosum	Ericaceae	S	N	E	Highbush blueberry
Vaccinium macrocarpon	Ericaceae	S	N	E	American cranberry
Vaccinium myrtilloides	Ericaceae	S	N		Canada blueberry
Vaccinium oxycoccus	Ericaceae	S	N	E	Small cranberry
Vaccinium pallidum	Ericaceae	S	N		Low-bush blueberry
Vaccinium stramineum	Ericaceae	S	N	X	Deerberry
Viburnum acerifolium	Caprifoliaceae	S	N		Maple-leaved arrowwood
Viburnum dentatum var. *deamii*	Caprifoliaceae	S	N		Southern arrowwood
Viburnum lantana	Caprifoliaceae	T/S	I		Wayfaring tree
Viburnum lentago	Caprifoliaceae	T/S	N		Nannyberry
Viburnum molle	Caprifoliaceae	S	N	E	Arrowwood
Viburnum opulus	Caprifoliaceae	S	I		European Cranberry-bush
Viburnum prunifolium	Caprifoliaceae	T/S	N		Black haw
Viburnum rafinesquianum	Caprifoliaceae	S	N		Downy arrowwood
Viburnum recognitum	Caprifoliaceae	S	N		Smooth arrowwood
Viburnum rufidulum	Caprifoliaceae	T/S	N		Rusty nannyberry
Viburnum trilobum	Caprifoliaceae	S	N		American cranberry-bush
Vitis aestivalis var. *aestivalis*	Vitaceae	L	N		Summer grape
Vitis aestivalis var. *argentifolia*	Vitaceae	L	N		Silver-leaved grape
Vitis cinerea	Vitaceae	L	N		Winter grape
Vitis labrusca	Vitaceae	L	I		Fox grape
Vitis palmata	Vitaceae	L	N		Catbird grape
Vitis riparia var. *praecox*	Vitaceae	L	N		Riverbank grape

(Table 2 continued)

Scientific name	Family	Habit	Native	E/T	Common name
Vitis riparia var. *riparia*	Vitaceae	L	N		Riverbank grape
Vitis riparia var. *styricola*	Vitaceae	L	N		Riverbank grape
Vitis rupestris	Vitaceae	L	N		Sand grape
Vitis vulpina	Vitaceae	L	N		Frost grape
Wisteria frutescens	Fabaceae	L	N		American wisteria
Zanthoxylum americanum	Rutaceae	S	N		Prickly-ash

Higher Fungi of Illinois Forests

Andrew S. Methven

Botany Department
Eastern Illinois University
Charleston, IL 61920

and

Walter J. Sundberg

Department of Plant Biology
Southern Illinois University
Carbondale, IL 62901

Although a number of systematics treatments have been completed for fungi in the Great Lakes region, the northeastern United States and Canada, the southern Appalachian Mountains, and the Pacific Northwest, knowledge of the fleshy higher fungi of many Midwestern states, including Illinois, lags far behind. Although Illinois was once dominated by prairies and is now covered by vast expanses of corn and soybeans, the paucity of information regarding Illinois fleshy higher fungi is not the result of a lack of fungi. Indeed, the unique vascular plant flora found in oak-hickory forests, northern hardwood forests, mesic bottomland forests, and forests of the Ozark Ridge is reflected in a diverse assemblage of fleshy higher fungi (Sundberg 1984). Instead, the absence of data on Illinois higher fungi is a reflection of the small number of mycologists who have resided in Illinois and studied these unique organisms. The lack of mycological studies on fleshy higher fungi in Illinois is obvious when one considers that, as of the mid-1980's, only 46 reports documenting 750 taxa could be found in mycological literature dating back to the late 1870's (Sundberg 1984). The paucity of information available is amplified when one realizes that the fungi included in these reports were collected in only 30 of Illinois' 102 counties. Thus, prior to the early 1970's, 71% of the counties in Illinois were essentially unexplored for fleshy higher fungi. Scarcity of data on Illinois higher fungi is further emphasized by the fact that the majority of the fungi included in these reports were collected in six counties: Cook, DuPage, Henry, Champaign, Jackson, and Union.

Fortunately this situation began to change following the arrival of Walter Sundberg at SIU-Carbondale in 1972 and several additional mycologists interested in fleshy higher fungi in the ensuing years. This paper is intended as an overview of fleshy higher fungi in Illinois, the data which has begun to accumulate on their occurrence and distribution, and the ecological role of these fungi in the maintenance and preservation of the Illinois' forests.

The life cycle of most higher fungi begins with the dispersal of spores from a sporocarp to a suitable substrate where they germinate and produce filamentous threads called hyphae (Alexopoulos and Mims 1979). The vegetative phase is thus composed of a massive network of rapidly elongating hyphal threads collectively termed a mycelium. The hyphae release enzymes into the substrate on which they grow to break down organic compounds into simpler, soluble forms. The resulting nutrient suspension is absorbed by the hyphae and used for growth. The life span of the mycelium is determined in part by the amount of organic material available, how rapidly it is used, and a variety of poorly understood components including climatic conditions, edaphic factors, and interactions among soil microorganisms. Not all of the nutritive material absorbed is used in producing new hyphae. A substantial amount is stored as glycogen, lipids or fats and used when environmental conditions are favorable for the formation of sporocarps. The sporocarps produce spores which are dispersed, and if they settle in a suitable habitat with proper environmental conditions, germinate and begin the

cycle anew.

Although the morphology of the vegetative stages of higher fungi are often monotonously similar, there is significant variation in the type of sporocarps fungi produce (Alexopoulos and Mims, 1979). As a result, the classification of fungi, like that of most organisms, is based primarily upon characteristics of the reproductive structures. When considered in this fashion, two very large and distinctive groups of fleshy higher fungi can be delimited, the Divisions Ascomycota and Basidiomycota.

The Division Ascomycota includes fungi that produce sac-like structures during the reproductive phase of the life cycle called asci which contain 4 or 8 ascospores (Alexopoulos and Mims 1979). The asci and ascospores are produced on or in sporocarps called ascocarps. Although many ascocarps are cup-shaped or disc-shaped (*e.g., Bisporella citrina* (Batsch: Fr.) Korf and Carpenter and *Galiella rufa* (Schw.) Nannf. and Korf), a wide range of forms are likely to be encountered in the forests of Illinois. For example, the cup or disc may be elevated on a distinct stalk (*e.g., Sarcoscypha occidentalis* (Schw.) Sacc. and *Urnula craterium* (Schw.) Fr.). Alternatively, the ascocarp may bear no resemblance to a cup but be shaped like a club (*e.g., Microglossum olivaceum* (Pers.: Fr.) Gill.), a fan (*e.g., Spathularia flavida* Pers.: Fr.) or a malformed head attached to the apex of a stalk (*e.g., Leotia lubrica* Pers.: Fr.). Finally, the apex of the ascocarp may be saddle-shaped with a fluted stalk (*e.g., Helvella crispa* Scop.: Fr.), cone-shaped and marked by various degrees of pitting (*e.g., Morchella elata* Fr.), or brain-like with irregular convolutions (*e.g., Gyromitra caroliniana* (Bosc: Fr.) Fr.).

The remaining fleshy higher fungi likely to be collected in Illinois are included in the Division Basidiomycota. These fungi produce basidiospores at the ends of projections called sterigmata which arise from the apex of club-shaped cells called basidia (Alexopoulos and Mims 1979). Many of the fungi included in the Division Basidiomycota produce fleshy basidiocarps on which the basidia line the surface of gills or lamellae which form on the undersurface of a cap or pileus which in turn is supported by a stalk or stipe. These basidiocarps are the "mushrooms" with which most of us are familiar (*e.g., Amanita rubescens* (Pers.: Fr.) S. F. Gray and *Laccaria ochropurpurea* (Berk.) Peck).

Not all members of the Basidiomycota form gill-bearing, mushroom-like basidiocarps and a variety of basidiocarp morphologies may be encountered in the forests of Illinois. In coral and club fungi, the basidia cover the surface of upright, branched or unbranched basidiocarps (*e.g., Clavaria aurantio-cinnabarina* Schw. and *Ramaria stricta* (Pers.: Fr.) Quel.) while the chanterelles form basidia in a smooth, wrinkled or gill-like layer on a mushroom-like basidiocarp (*e.g., Cantharellus lateritius* (Berk.) A. H. Smith and *Cantharellus cinnabarinus* Schw.). The boletes form fleshy basidiocarps in which the basidia line the inner surface of pendant tubes which open to the environment as pores (*e.g., Boletus pallidus* Frost and *Strobilomyces floccopus* (Vahl.: Fr.) Karsten). Hedgehog or spine fungi produce basidiocarps in which the basidia cover the surface of pendant spines or teeth (*e.g., Hericium erinaceus* (Bull.: Fr.) Pers. and *Hydnum repandum* L.: Fr.). The polypores produce leathery to woody basidiocarps that often form shelving masses on trees and fallen logs and also produce basidia which line the inner surface of pendant tubes (*e.g., Polyporus alveolaris* (DC: Fr.) Bond. and *Trametes versicolor* (L.: Fr.) Pilat). The jelly fungi are also found primarily on fallen logs but produce gelatinous, amorphous basidiocarps which bear four-celled basidia (*e.g., Tremella foliacea* Pers.: Fr. and *Exidia glandulosa* Bull.: Fr.).

Particularly odd among the Division Basidiomycota are those fungi included in the Class Gasteromycetes. The Gasteromycetes include fungi in which the basidiospores are not forcibly discharged and are enclosed within the basidiocarps even at maturity. Puffballs (*e.g., Lycoperdon perlatum* Pers.), earth stars (*e.g., Geastrum saccatum* Fr.), bird's nest fungi (*e.g., Cyathus striatus* (Huds.) Willd. per Pers.), and stinkhorns (*e.g., Phallus impudicus* L. per Pers.) are examples.

The inability of fungi to manufacture their own organic matter through photosynthesis is the key to their role in nature's scheme (Hudson 1972). Fungi are directly or indirectly dependent on the organic materials provided by plants and animals. Thus, plants and other groups of organisms build up organic matter and fungi break it down. As a result, fungi have become adapted to a variety of natural

and synthetic substrates and have evolved fascinating relationships with other forms of life.

Fungi which survive solely on, and at the metabolic expense of, other living organisms are called obligate parasites (Wheeler 1968). Plant rusts such as *Puccinia podophylli* Schw., causal agent of May Apple Rust, and *Gymnosporangium juniperi-virginianae* Schw., causal agent of Cedar Apple Rust, are examples of obligate parasites. One of the more curious aspects of such parasitic interactions is that the fungus does not ordinarily kill the host upon which it is living and thus does not destroy its source of nourishment.
For if the host dies, the parasite perishes as well.

Not all fungal pathogens are obligate parasites. Many can attack a host, kill it, and continue to thrive on the remains until the nutritive material has been exhausted (Manion 1981). These fungi are referred to as facultative parasites because they can exist on either living or dead organic matter. Examples include *Armillaria mellea sensu lato* and *Ganoderma lucidum* (Leysser: Fr.) Karst., both of which cause destructive root and heart rots in a variety of deciduous trees, and *Phaeolus schweinitzii* (Fr.) Pat. which causes a root and stump rot of old growth pines.

Fungi which flourish on dead organic matter are called saprobes (Park 1968, Hudson 1972). Saprobic fungi are described as being terrestrial when found growing in the humus or soil (*e.g., Russula compacta* Frost), foliicolous when observed on leaves (*e.g., Marasmius capillaris* Morgan), and lignicolous if they inhabit wood (*e.g., Pleurotus ostreatus* (Jacq.: Fr.) Kummer). Saprobic taxa such as *Agaricus campestris* L.: Fr. and *Chlorophyllum molybdites* (Meyer: Fr.) Mass. which thrive on dead grasses, are likely to have long-lived mycelia since their food supply is replenished each year. One can expect to find these fungi in the same general location over a long period of time. If there are no obstructions and food material is evenly distributed, the mycelium grows outward in all directions from the initiation site, and the sporocarps are likely to be produced at or near the perimeter of the mycelium in the form of "fairy rings."

Were it not for the activity of fungi, fallen trees, logs, and other debris would never decay (Park 1968, Hudson 1972). A considerable division of labor in a woodland habitat occurs between fungi whose activities are often obscured by the substrate within which they grow. In fact, only after the vegetative phase of a fungus becomes established and is digesting the substrate it occupies does the process we know as decay become evident. In nature, one might expect to find the mycelium of several different fungi colonizing a single rotting log and effectively competing with one another for the available supply of organic matter (Park 1968). In reality, however, not all the fungi in a particular substrate appear to compete with one another. In a fallen hardwood tree, for example, species A may digest only cellulose whereas species B may digest both cellulose and lignin. Although these two species digest cellulose, and cellulose and lignin, respectively, they may not break these compounds down into their ultimate products. Instead, different fungi appear subsequent to those which first attacked the log and further reduce the substrate into simpler forms. Thus a succession of fungi is expected in the process of reducing a log to humus (Park 1968, Hudson 1972).

One can also understand how disturbances in a forest can alter the kinds of fleshy higher fungi observed (Park, 1968). Fire, for example, may alter the fungi in a forest even if the forest is not completely destroyed or soon reproduces itself. When the litter layer is burned, fungi which live within it are often drastically reduced or eliminated and replaced within a season or two by fungi which appear in great numbers but may not have been found previously in the forest. For example, *Anthracobia melaloma* Boud. and *Peziza violacea* Pers. Fr. are rarely encountered except on charred debris and ashes around and under burned stumps and logs. Any disturbances which alter the soil surface in a forest, such as flooding, clear-cutting or road-cutting are also likely to influence the kind of fungi living there. For example, tillage or road-cutting often induces the formation of fungi such as stinkhorns (*e.g., Dictyophora duplicata* (Bosc) E. Fischer) or puffballs (*e.g., Scleroderma polyrhizon* Pers.).

Most mycologists recognize that many fleshy fungi are regularly found in close proximity to particular trees. For example, *Boletinellus merulioides* (Schw.) Murrill is found in association with ash, *Suillus*

americanus (Peck) Snell ex Slipp and Snell is only collected beneath white pine, and *Amanita rubescens* (Pers.: Fr.) S. F. Gray is restricted to oak woods. These associations are readily explained by highly specific symbiotic associations called mycorrhizae which form between fungal hyphae and the roots of vascular plants (Harley and Smith 1983). The plants benefit because the fungal hyphae permeate the soil and are capable of absorbing water and inorganic nutrients which may be present in areas or forms that are inaccessible to plants. This is particularly important for plants which inhabit xeric, nutrient poor soils and may often make the difference between survival or mortality during a drought. In addition, the fungal hyphae may provide the plant with protection from certain soil borne pathogens such as nematodes, viruses, and bacteria. For its effort, the fungus receives a ready supply of carbohydrates for growth and reproduction.

Since many fungi form mycorrhizal or parasitic associations with specific plants or function as saprobes and agents of decay on a variety of substrates, there are considerable differences between the fleshy higher fungi observed in deciduous, mixed coniferous-deciduous or coniferous forests (Harley and Smith 1983). An oak-hickory forest, for example, will contain species of fungi not found in a beech-maple forest while pine plantations are characterized by another unique group of fleshy fungi. It is this diverse assemblage of fleshy higher fungi which mycologists in Illinois have finally begun to explore.

Initially we mentioned the paucity of information regarding fleshy higher fungi in Illinois forests and some of the reasons for it. The situation has begun to change dramatically within the last twenty years due to the arrival of a number of resident mycologists interested in systematics of fleshy higher fungi. These individuals have collected in poorly known and unexplored mycological areas and contributed substantially to the knowledge of Illinois fleshy higher fungi (Doyle 1987,1989, Methven 1990, Mueller 1992, Mueller and Sundberg 1981, Parody and Sundberg 1977, Wason 1989, Wason *et. al.* 1991, West 1976). In addition to these studies, the first in a series of publications on genera of Illinois fleshy higher fungi is in preparation. Although we currently lag far behind, the knowledge of Illinois' fleshy higher fungi may soon begin to approach that of other regions in North America.

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Illinois Department of Conservation Division of Forest Resources Nursery Program

Stewart Pequignot

Illinois Department of Conservation
Springfield, Illinois 62794-9225

ABSTRACT

The Division of Forest Resources operates two nurseries--the Mason State Nursery at Topeka, Illinois in Mason County, and the Union State Nursery at Jonesboro, Illinois in Union County. Both facilities have been in operation since the early 1930's. A recent nursery expansion and rehabilitation program and new programs for diversifying stock production demonstrate that plant materials can be produced for a wide variety of natural community restoration programs.

PRODUCTION HISTORY

During the 1930's and into the 1940's, nursery produced seedlings were used for planting surface-mined lands, Department of Conservation properties, and Soil Conservation Service projects. Of the plants produced, less than 20% were used on private lands. Starting in the late 1940's, and into the 1960's, over 85% of the seedlings were used on private lands. Annual nursery production peaked at 11,745,000 seedlings in 1957. This production level was a result of the Federal Soil Bank Program.

In 1957, over 72% of the production was conifer species. Shrub species (mainly multiflora rose) accounted for 23% of the production. Less than 5% of the seedlings shipped were native hardwoods.

While this percentage breakdown (large emphasis on conifers) continued into the early 1980's, a change in production strategy occurred in 1983. This change in strategy resulted in a major shift in emphasis from conifers to native hardwoods and involved the discontinuation of the production of non-native plant species (such as amur honeysuckle and autumn olive). The distribution of production in 1992 was -- 25% conifers, 56% native hardwood trees, 16% native shrub species and 3% prairie forbs.

In 1957 the nurseries were involved in producing about 15 species. Today both the Mason and Union Nurseries are involved in the production of over 130 plant species. Production involves 35 native tree species, 18 native shrub species, 47 prairie forb species, 7 warm-season grasses, 20 woodland understory trees, shrubs and herbaceous species, and 11 wetland species. Table 1 shows the tree and shrub production goals for both nurseries for the 1993-1994 planting season.

SEED PROCUREMENT

Procurement of seed is a major activity for the nurseries. With the exception of conifer species and black locust, seeds are obtained from plants growing in Illinois. Seed collection assistance is provided by personnel from the Department's other divisions.

Seeds for the oak species, black walnut and several other hardwoods are obtained by means of a Permit Seed Collection Program. Table 2 is a list of species involved in the permit program.

District Forester offices located across the state are used as collection centers for the seeds purchased through the permit program. The foresters are given quotas of seed that they may purchase. Individuals must obtain a permit prior to bringing seed in for sale. The issuance of a permit controls the purchase of seed and prevents the various offices from purchasing seed in excess of budgeted amounts. State employees and family members are prohibited from participating in this program.

In 1991, over 400 individuals collected 387,873 pounds of seed. The cost of this collection effort was over $117,000. The 1992 collection program had been scaled back due to reductions in the Division's budget. The total dollar amount for this program in 1992 was $85,800.

The existing seed collection program enhances nursery production through increased genetic diversity. Prior to the introduction of this program, seed collection was done by nursery crews and occurred within a fifty (50) mile radius of the two nurseries. Plants produced under this old system had very limited genetic diversity. With the existing program, we are obtaining seeds from all areas of the state. Genetic diversity is important to our nursery program because of the climatic differences that occur over the approximately 400 mile north to south length of the State of Illinois.

As a part of our seed collection program, the state has been divided into three collection zones. In the case of the fine hardwoods (walnut and oaks), seedlings are shipped back to the zone where the seed originated. This provides landowners with seedlings best suited for their particular growing conditions.

Other tree and shrub species are collected, where possible, from the three zones but not kept separate by zones. The collection of seed from all three zones results in plants that can be expected to survive the range of climatic conditions that occurs from northwestern to southern Illinois.

In some cases seedlings and seeds are obtained through stock exchange agreements with other mid-western states. Illinois and Indiana have had a long standing stock exchange agreement. This agreement involves five or six species and allows each state to reduce the total number of species being grown. These two states can obtain additional species from each other through the exchange program.

TREE IMPROVEMENT PROGRAMS

In 1981, with assistance from the United States Forest Service (USFS), a black walnut seed orchard was started at the Union Nursery. This 14-acre orchard was designed to provide improved black walnut seeds for the production of seedlings for plantings in the southern half of Illinois. With the approval of a federally funded focus project through the USFS's State and Private organization, this orchard was completed in the spring of 1989. This orchard has 46 different clones. Many of these clones are second and third generation selections from ongoing tree improvement programs in the Midwest. The 1989 focus project also included funds to develop another 20-acre orchard to serve northern Illinois. This second orchard was established with grafted material in the spring of 1990.

In cooperation with the North Central Fine Hardwoods Tree Improvement Cooperative, we have been actively searching for superior selections of black walnut trees. Selections are from either natural stands or plantations. There have been 94 selections made in Illinois. Successful grafts have been completed for 90 of these selections. These grafts are located in orchards or sublines in Illinois, Wisconsin, and Missouri. These selections will result in the introduction of additional genetic diversity into the cooperative's eight state tree improvement programs.

In 1990 a 1.5-acre black walnut subline of Illinois selections was established at the Mason Nursery. In the spring of 1993 a second 2-acre black walnut subline will be planted at the Mason Nursery. The Union Nursery will also be establishing a two (2) acre black walnut subline in 1993. Sublines, while they will function as seed orchards, are a part of the long term breeding strategy of the North Central Fine Hardwoods Tree Improvement Cooperative.

In 1992 seed collection areas were established at the Union Nursery for the following species: red oak-10 acres, swamp white oak-1.3 acres, white oak-1 acre. In addition to the seed collection areas at the Union Nursery, a 10-acre cherrybark oak seed collection area was established at the Horseshoe Lake Conservation Area.

The seed collection areas were established using selected seedlings from the nurseries' production. All collection areas contain seedlings from the designated North, Central and Southern zones. The collection areas are blocked to allow for the collection of seed by zones.

In 1992, a 1.5-acre red oak seed orchard was established at the Mason Nursery. The red oak seed orchard was established with 121 selections taken from a 1988 Iowa State University root morphology study planting at the Mason Nursery.

PRAIRIE RESTORATION PROGRAM

In 1977, the Department began a prairie restoration program on state owned properties. In order to have a supply of native ecotype seeds, the Mason Nursery was requested to establish a warm-season grass seed collection area. As a result of this request, a seed collection area of 3 acres involving 5 different grass species was established in 1978. In 1985, an additional 8-acre grass collection area was established. Expansion plans called for a total grass production area of approximately 43 acres. This additional acreage was planted in 1992.

Since 1978, the Mason Nursery's prairie program has expanded to include 7 grass species and over 40 forb species. In 1991, 293,457 forb seedlings were distributed. Forb seed collection yielded 987 pounds of seed. Grass seed harvest from the Mason Nursery and other state sites totaled 3,260 pounds. Species of plants included in the Mason Nursery prairie plant and seed production program are listed in Table 3.

The completion of a grass seed processing facility and the purchase of new equipment that is used for tree, shrub, and forb species has resulted in a drastic improvement in seed quality. This will help insure the establishment of the many prairie restorations that are being undertaken by the Department's Division of Natural Heritage.

The Department's Division of Natural Heritage and Division of Wildlife Resources biologists supplement the nursery's grass and forb seed production with collections from native stands of grasses and forbs growing in their respective districts.

In addition to the production of prairie plant materials for restoration work on state lands, another important aspect of the Mason Nursery's prairie program involves the protection and production of Illinois endangered plant species. There are many endangered plant species in Illinois. In many cases there are only small communities or individual plants left of these species. The collection of seed and subsequent production of plants, as well as the establishment of the plants in our forb collection areas, is helping to assure the availability of these plants for future generations.

The production of the prairie plant materials involves about 20 to 30% of nursery work activities. The cost of producing these plant materials is approximately $126,000 yet it results in the production of plant materials worth over $500,000.

OTHER PLANT PRODUCTION PROGRAMS

In 1991 the Mason Nursery began growing woodland herbaceous plants. The nursery is currently working with twenty (20) species of small trees, shrubs, and woodland wildflowers. This is a pilot program designed to develop a source of plant material for the restoration of forest understory natural communities (Table 4).

In the fall of 1992 the Mason Nursery made some initial seed and plant collections of wetland species. Nursery personnel will be looking into the possibility of growing a variety of species, either from seeds or by vegetative propagation, for the purpose of developing plant material that can be used in wetland restorations (Table 5).

DISTRIBUTION OF PLANT MATERIALS

As a result of new nursery enabling legislation passed in 1987, landowners with management plans approved by their District Forester, Wildlife Biologist, or Heritage Biologist are able to obtain planting stock at no cost. The majority of seedlings distributed through the nursery program are utilized by landowners with management plans. Landowners with approved management plans have a priority for receiving plant materials until the end of January. This priority system has resulted in better utilization of our planting stock. Our district personnel now have the ability to better match soil types and species and to give preference to those landowners willing to implement approved management practices.

Landowners who do not have approved management plans may still purchase seedlings from the Department. These purchasers must wait until

February 1st before their orders may be submitted. In many cases there are limited amounts and species of plants available after this date.

This new legislative language also required a revision in the method used to price plant materials. Prior to 1987, planting stock sold through the nurseries was priced at 20 to 30% of its production cost. Prices for planting stock now reflect actual production costs. Landowners ordering plant materials without an approved management plans must pay the full cost of production.

NURSERY REHABILITATION AND EXPANSION

The following is a portion of an article about the Mason Nursery that appeared in the March 12, 1938 issue of "The Prairie Farmer":

> "... The ultimate aim of the Division of Forestry is to produce a minimum of 10,000,000 trees per year for reforestation purposes in this state. There is no question that this amount will be necessary. The 1935 census showed that Illinois contained approximately 7,000,000 acres of land that is neither producing farm crops, nor is used for ordinary pasture. Some 3,000,000 acres of this is classed as timber land. The greatest amount of our 3,000,000 acres of timber land is owned in small areas on farms. The balance of approximately 4,000,000 acres is neither producing nor is satisfactory for production of farm crops, is not producing timber and is not satisfactory for pasture.
>
> The State Department of Conservation, Division of Forestry, intends to expand its efforts to raise healthy planting stock in its nurseries at a price within the reach of those who own lands in need of reforestation. It is hoped that those who own that land will cooperate with the state and obtain this planting stock to adequately reforest that portion of their farms or lands that are unfit for agriculture, thereby insuring Illinois of proper supply of forests and timber..."

With the exception of the reference to the 1935 census, these paragraphs or ones very similar to them have appeared in recent justifications for nursery expansion. Expansion needs have been driven by demands generated by the Federal Conservation Reserve Program (CRP) and the State's Forest Development Act (FDA).

Illinois has had an exceptional response to CRP tree planting sign-ups. Federal Conservation Reserve Program sign-ups, as a result of the 1985 and 1990 Farm Bills, have resulted in over 30,000 acres being designated for tree planting. The demands for planting stock generated by the CRP program has not allowed the Department to meet all of the needs for plant materials. In order to meet the deadlines established by the two Federal Farm Bills production needs to exceed 15 million seedlings per year.

The expansion and rehabilitation of the Department's nurseries has resulted in approximately $6 million of work being completed or scheduled for completion at the two nursery facilities. This work has included--1) A new office/packing facility at the Mason Nursery. 2) Conversion of the old packing facility at the Mason to a seed processing building. 3) Construction of a warm-season grass processing facility. 4) Construction of a 3,000 square foot greenhouse for the container production of prairie plants. 5) Construction of center-pivot irrigation system for the warm-season grass production areas. 6) Construction of a shade house for the production of large container grown plants for plantings on Department facilities. 7) Seedbed development of eighty acres for the production of bare root trees and shrubs. 8) Construction of a equipment storage building at the Mason Nursery. 9) Construction of a new office complex at the Union Nursery. 10) Expansion and rehabilitation of cold storage facilities at the Union Nursery. 11) Construction of additional space at the Union Nursery for the storage of shipping materials and processing orders for shipping. 12) Construction of chemical storage rooms, service bays and additional storage space at

the Union Nursery. 13) Rehabilitation of the seed cleaning facilities at the Union Nursery. 14) Addition of a standby pump at the Union Nursery for irrigation of seedbeds. 15) Repair and replacement of stream bed retaining walls to protect buildings and seedbeds at the Union Nursery. 16) Construction of residences at both nurseries. 17) Development of additional seedbed area at the Union Nursery. 18) Tiling and drainage improvements in the black walnut seed orchards at the Union Nursery.

With the completion of the Department's nursery expansion and rehabilitation program, the Division of Forest Resources will have the facilities necessary to meet the ever increasing demand for plant materials. These capital resource combined with the Department's willingness to support the production of a variety of native plant species has enabled Illinois' nursery program to become a model for the rest of the Nation's public nurseries. Illinois' program demonstrates that, with a willingness to abandon traditional nursery production patterns, plant materials can be produced for a wide variety of natural community restoration programs.

Table 1. Tree and shrub species, 1993/94 nursery production goals.

COMMON NAME	SCIENTIFIC NAME	PRODUCTION GOALS (1,000's)
PECAN	*Carya illinoensis*	30
HICKORIES	*Carya sp.*	50
HACKBERRY	*Celtis occidentalis*	50
WHITE ASH	*Fraxinus americana*	175
GREEN ASH	*F. pennsylvanica*	300
BLACK WALNUT	*Juglans nigra*	375
RED CEDAR	*Juniperus virginiana*	60
SWEETGUM	*Liquidambar styraciflua*	75
RED PINE	*Pinus resinosa*	175
WHITE PINE	*P. strobus*	1,000
BLACK CHERRY	*Prunus serotina*	40
WHITE OAK	*Quercus alba*	250
BUR OAK	*Q. macrocarpa*	150
PIN OAK	*Q. palustris*	150
RED OAK	*Q. rubra*	300
BLACK OAK	*Q. velutina*	150
SWAMP WHITE OAK	*Q. bicolor*	15
CHERRYBARK OAK	*Q. falcata*	50
MISC. NATIVE SP.	Various species	59
BALD CYPRESS	*Taxodium distichum*	275
BLACK LOCUST	*Robinia pseudoacacia*	5
RIVER BIRCH	*Betula nigra*	15
SYCAMORE	*Platanus occidentalis*	25
SILVER MAPLE	*Acer saccharinum*	20
SUGAR MAPLE	*A. saccharum*	20
RED MAPLE	*A. rubrum*	5
PERSIMMON	*Diospyros virginiana*	25
TULIP TREE	*Liriodendron tulipifera*	50
LOBLOLLY PINE	*Pinus taeda*	100
GRAY DOGWOOD	*Cornus racemosa*	90
SILKY DOGWOOD	*C. amomum*	75
HAZELNUT	*Corylus americana*	90
WASH. HAWTHORN	*Crataegus phaenopyrum*	20
NATIVE CRABAPPLE	*Malus ioensis*	5
AMERICAN WILD PLUM	*Prunus americana*	50
SMOOTH SUMAC	*Rhus glabra*	5
BLACKBERRY	*Rubus allegheniensis*	3
ELDERBERRY	*Sambucus canadensis*	10
CORALBERRY	*Symphoricarpos orbiculatus*	3
BLACK CHOKEBERRY	*Aronia melanocarpa*	10
RED OSIER DOGWOOD	*Cornus stolonifera*	5
COCKSPUR HAWTHORN	*Crataegus crus-galli*	3
FRAGRANT SUMAC	*Rhus aromatica*	5
STAGHORNN SUMAC	*R. typhina*	5
REDBUD	*Cercis canadensis*	12
H. B. CRANBERRY	*Viburnum trilobum/opulus*	25
OTHER VIBURNUM	*Viburnum sp.*	15
PRAIRIE FORBS	Various species	300
	TOTAL	4,725

Table 2. Permit seed collection program.

SPECIES	PRICE PER POUND	AMOUNT OF SEED (LBS)
HICKORIES	$ .75	6,000
HACKBERRY	$5.00	300
BLACK WALNUT	$ .10	275,000
RED OAK	$ .90	14,000
WHITE OAK	$ .90	12,000
BUR OAK	$ .60	12,000
BLACK OAK	$1.10	4,000
PIN OAK	$1.90	3,000
PECAN	$1.00	1,750
CHINKAPIN OAK	$1.90	600
SHUMARD OAK	$0.90	500
SWAMP WHITE OAK	$1.10	600
CHERRYBARK OAK	$3.00	1,500
SHINGLE OAK	$0.60	200
HAZELNUT	$5.00	600

Table 3. Prairie grass and forb species.

PRAIRIE GRASS SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE
BIG BLUESTEM	*Andropogon gerardii*	MESIC
SIDEOATS GRAMA	*Bouteloua curtipendula*	DRY
SWITCH GRASS	*Panicum virgatum*	WET/MESIC
LITTLE BLUESTEM	*Schizachryium scoparium*	MESIC/DRY
INDIAN GRASS	*Sorghastrum nutans*	MESIC
NORTHERN DROPSEED	*Sporobolis heterolepis*	MESIC/DRY
EASTERN GAMA GRASS	*Tripsacum dactyloides*	MESIC

PRAIRIE FORB SPECIES

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE
NODDING WILD ONION	*Allium cernuum*	MESIC/DRY
LEAD PLANT	*Amorpha canescens*	MESIC/DRY
THIMBLE WEED	*Anemone cylindracea*	DRY
SULLIVANT'S MILKWEED	*Asclepias sullivantii*	MESIC
BUTTERFLY WEED	*Asclepias tuberosa*	MESIC/DRY
SMOOTH ASTER	*Aster laevis*	MESIC
NEW ENGLAND ASTER	*Aster novae-angliae*	MESIC
TENN. MILKVETCH	*Astragalus tennesseensis*	MESIC/DRY
WHITE FALSE INDIGO	*Baptisia leucantha*	MESIC/DRY

Table 3 continued. Prairie grass and forb species.

FALSE INDIGO	*Baptisia leucophaea*	MESIC/DRY
D. FALSE ASTER	*Boltonia decurrens*	WET
INDIAN PLANTAIN	*Cacalia tuberosa*	MESIC/DRY
WILD HYACINTH	*Camassia scilloides*	MESIC
NEW JERSEY TEA	*Ceanothus americanus*	MESIC/DRY
LANCE LEAF COREOPSIS	*Coreopsis lanceolata*	DRY
STIFF TICKSEED	*Coreopsis palmata*	MESIC/DRY
WHITE PRAIRIE CLOVER	*Dalea candida*	MESIC/DRY
LACEY PRAIRIE CLOVER	*Dalea foliosa*	DOLOMITE
PURPLE PRAIRIE CLOVER	*Dalea purpurea*	MESIC/DRY
ILLINOIS MIMOSA	*Desmanthus illinoensis*	DOLOMITE
CANADA TICK TREFOIL	*Desmodium canadense*	MESIC
ILL. TICK TREFOIL	*Desmodium illinoense*	MESIC/DRY
PURPLE P. CONEFLOWER	*Echinacea pallida*	MESIC/DRY
RATTLESNAKE MASTER	*Eryngium yuccifolium*	MESIC
WESTERN SUNFLOWER	*Helianthus occidentalis*	DRY
ALUM ROOT	*Heuchera richardsonii*	DRY
KANKAKEE MALLOW	*Iliamna remota*	DRY
WILD BLUE IRIS	*Iris shrevei*	WET
P. BUSH CLOVER	*Lespedeza capitata*	MESIC/DRY
NARROWHD BUSH LESP.	*Lespedeza leptostachya*	DRY
ROUGH BLAZING STAR	*Liatris aspera*	DRY
TALL GAYFEATHER	*Liatris pycnostachya*	MESIC
SPIKE BLAZING STAR	*Liatris spicata*	WET/MESIC
WILD BERGAMOT	*Monarda fistulosa*	MESIC/DRY
GLADE MALLOW	*Napaea dioica*	WET
AMERICAN FEVERFEW	*Parthenium integrifolium*	DRY
OBEDIENT PLANT	*Physostegia virginiana*	DRY
PRAIRIE CINQUEFOIL	*Potentilla arguta*	MESIC
GRAY HD. CONEFLOWER	*Ratibida pinnata*	MESIC
CAROLINA ROSE	*Rosa carolina*	MESIC/DRY
ROYAL CATCHFLY	*Silene regia*	DRY
ROSIN WEED	*Silphium integrifolium*	MESIC/DRY
COMPASS PLANT	*Silphium laciniatum*	MESIC
PRAIRIE DOCK	*Silphium terebinthinaceum*	MESIC/DRY
RIGID GOLDENROD	*Solidago rigida*	MESIC/DRY
SPIDERWORT	*Tradescantia ohiensis*	MESIC/DRY
GOLDEN ALEXANDER	*Zizia aurea*	MESIC/DRY

Table 4 . A list the plants grown in the forest understory plant production program.

FOREST UNDERSTORY SPECIES

COMMON NAME	SCIENTIFIC NAME
DOLL'S EYES	*Actaea pachypoda*
JACK-IN-THE-PULPIT	*Arisaema triphyllum*
COMMON PAWPAW	*Asimina triloba*
AMERICAN HORNBEAM	*Carpinus caroliniana*
SPRING BEAUTY	*Claytonia virginica*
TOOTHWORT	*Dentaria laciniata*
DUTCHMAN'S BREECHES	*Dicentra cucullaria*
SPICEBUSH	*Lindera benzoin*
CINNAMON FERN	*Osmunda cinnamomea*
GINSENG	*Panax quinquefolius*
MAYAPPLE	*Podophyllum peltatum*
SOLOMON'S SEAL	*Polygonatum commutatum*
AZALEA	*Rhododendron sp.*
BLOODROOT	*Sanguinaria canadensis*
FALSE SOLOMON'S SEAL	*Smilacina racemosa*
STARRY F. SOLOMON'S SEAL	*Smilacina stellata*
WHITE TRILLIUM	*Trillium gleasonii*
PURPLE TRILLIUM	*Trillium recurvatum*
LOW BUSH BLUEBERRY	*Vaccinium angustifolium*
COMMON VIOLET	*Viola papilionacea*

Table 5. A list of the plants grown in the wetland production program.

WETLAND SPECIES

COMMON NAME	SCIENTIFIC NAME
SWAMP MILKWEED	*Asclepias incarnata*
BLUE JOINT GRASS	*Cala magrostis canadensis*
SEDGE	*Carex sp.*
BONESET	*Eupatorium perfoliatum*
RICE CUT GRASS	*Leersia oryzoides*
CARDINAL FLOWER	*Lobelia cardinalis*
BLUE LOBELIA	*Lobelia siphilitica*
SWAMP ROSE	*Rosa palustris*
PUSSY WILLOW	*Salix discolor*
BULL RUSH	*Scirpus sp.*
CORD GRASS	*Spartina pectinata*

What is Killing the Pines in Illinois?

James E. Appleby

Department of Forestry
University of Illinois
Urbana, Illinois 61801

It was not uncommon during the 1970's for homeowners to inquire from their local extension personnel the reason for their pine trees dying. Extension agents would contact research plant pathologists and entomologists for help. The researchers would examine the dead trees, but there was never any evidence to the cause of death. Often the trees were in a vigorous growing condition, when in late spring to late summer the color of the needles would sudden turn pale green and then brown. I recall one instance when a plant pathologist determined the cause of death as physiological disturbance. Indeed, death is the ultimate physiological disturbance.

In February 1979 at Columbia, Missouri, an interesting change of events took place. A trunk portion of an Austrian pine arrived at Einar Palm's diagnostic clinic at the University of Missouri, Columbia. Information with the sample explained that the 39 year old pine suddenly died during the previous summer. By chance a scientist from Japan was visiting that day, and suggested that in Japan a nematode, *Bursaphelenchus xylophilus,* was involved in the death of huge numbers of pines in Japan. That day the log was examined and found to contain large numbers of nematodes which were later identified by V. H. Dropkin, a University of Missouri nematologist, as the same nematode species that occurs in Japan. The species determination was later confirmed by Y. Mamiya, the scientist who had originally described the species in Japan. The discovery was published in 1979 (Dropkin and Foudin 1979). *B. xylophilus,* the pinewood nematode, was therefore implicated in causing pine wilt disease. The finding excited scientists throughout the nation to find more information.

Robbins (1982) compiled reports of the pinewood nematode in the United States and showed that the nematode was found to occur in 34 states and found in 20 species of pine with Scotch pine, *Pinus sylvestris*, being reported as the most common host. In the same report several non-pine conifers were found as hosts. These included atlas cedar, *Cedrus atlantica*, deodar cedar, *C. deodara*, balsam fir, *Abies balsamea*, European larch, *Larix decidua*, tamarack, *L. laricina,* blue spruce, *Picea pungens*, and white spruce, *P. glauca*. In all of the non-pine hosts the incidence of the nematode was indeed rare. Incidence of pine wilt in the Midwest is most common in Scotch pine, *P. sylvestris*, moderate in red pine, *P. resinosa*, Austrian pine, *P. nigra*, and occasionally found in jack pine, *P. banksiana*, loblolly pine, *P. taeda*, Virginia pine, *P. virginiana* and rare in mugo pine, *P. mugo*, and white pine, *P. strobus*.

Malek and Appleby (1984) gave a detailed account of the pine wilt symptom development in Scotch pine stating that there were 4 distinct stages in foliar coloration from light grayish green to totally brown. It was also indicated that there were two general periods of tree death, late winter to late spring and midsummer to late fall.

"The nematode was recovered in population densities up to 20,000/g of wood (dry wt) from sections of branches from dead, needle-bearing pines. It often was abundant in roots down to 2 cm in diameter and up to 2 m from the bases of young trees. The nematode was detected easier and usually in higher populations in trees that died during the summer-fall period. Though present in trunks, it frequently was absent from branch wood at any stage of symptom development in spring mortalities. It was never found in needles and cones and was rare in terminal twigs. The dispersal nematode stage was recovered in declining numbers from the trunks of standing pines up to 3 years after tree death (Malek and Appleby 1984)."

A bluestain fungus, *Ceratocystis* ssp., is evident in cross sections of wood from trees that die of pine

wilt. The fungus appears as a dark blue-black stain, triangular in shape, with the tip radiating from the center of the wood. In laboratory cultures it was found that the nematode readily reproduced in agar plates infested with the fungus.

The disease cycle in Japan involves a beetle, nematode, and a fungus relationship. With this knowledge, investigations began in 1979 to find whether a similar relationship might exist in the United States. A longhorned beetle, *Monochamus alternatus*, is the primary nematode vector in Japan. This insect does not occur in the United States, but closely related *Monochamus* species are found throughout most parts of the U.S. Holdeman (1980) complied a list of insect species in the United States which were found to be infested with *B. xylophilus* nematodes; these include: *M. carolinensis, M. scutellatus, M. titillator, M. obtusus,* and *Arhopalus rusticus obsoletus.*

In Illinois and throughout the Midwest the primary insect vector of the pinewood nematode is the Carolina pine sawyer, *M. carolinensis* (Appleby 1982, Linit 1982). This sawyer is by far the most common species and the most abundant. Detailed studies of the biology of the Carolina pine sawyer were conducted by Pershing and Linit (1986, 1988), Walsh and Linit (1984, 1985) and Wingfield (1983). Other sawyer beetles in Illinois found to be pinewood nematode vectors were *M. scutellatus, M. notatus*, and *M. titillator.*

In life history studies of the Carolina pine sawyer conducted in Illinois, it was found that the adult beetles began emerging from pine wood in late May, with continued emergence until early August. Peak emergence occurred in the latter half of June. The average life span of an adult beetle is about 55 days. A sawyer beetle is capable of carrying thousands of nematodes. Nematode numbers of up to 90,000 per beetle were recorded with the average number being 21,000 (Malek and Appleby 1984). The newly emerged adult sawyer beetles feed on the current or one-year old pine twigs. Under favorable temperature and moisture conditions, the nematodes emerge from the beetles' spiracles and enter the twigs through the feeding wounds. The 0.5 mm long (1/30 inch) nematodes migrate to the resin canals of the pine branch. The adult nematodes mate and the females begin producing eggs. In laboratory studies Mamiya (1975) reported that the development from egg to adult takes 4 to 5 days at a temperature of 25 C° (77 F°). During the 28 day egg laying period, each female nematode produced an average of 28 eggs (Mamiya 1975).

During the summer months, nematodes reproduce rapidly and tree death can occur in as little as two months after the introduction of the nematodes. The dead wood is rapidly invaded by a blue stain fungus.

Female sawyer beetles deposit eggs in weakened, pine wilt killed or dead pines. At night the female beetle, after mating, chews small funnel-shaped depressions in the tree trunk after which a single egg is inserted at the bottom of the pit between the hardened and outer bark layer. The white elongate oval egg is about 2.9 mm long (1/8 inch). Eggs deposited in early August, 1981 at Urbana, IL hatched 8 days later. Upon hatching from the egg, the small beetle larva mines under the tree bark, and as it matures it invades the hardwood of the tree. The following year, spring or summer, the beetle changes into the inactive pupa stage. It is during the time that the beetle is in the pupa stage that large numbers of nematodes are attracted to the pupal chamber. During the development of the pupa and adult beetle stage, large numbers of nematodes invade the breathing tubes or tracheae of the adult beetle. It is generally the thoracic spiracles or breathing pores of the beetle that are invaded. Nematodes were found to leave the beetles' bodies during the entire time the beetles are in the adult stage.

Although the nematode appears to be the primary agent responsible for tree death, Oku *et al.* (1979, 1980), Kondo *et al.* (1982), and Bolla *et al.* (1982) have shown that a phytotoxin is involved in the death of trees. Extracts from pine wilt killed trees that contained no nematodes, fungi, virus, or bacteria when inoculated into pine seedlings resulted in the death of the seedlings. "It is possible that the phytotoxin is a product of the tree's synthesis. It might be suggested either that the phytotoxin is directly synthesized by the tree in response to the nematode or that a monoterpene material not toxic to the tree, but having phytoalexin activity against the nematode is synthesized by the tree in response to infection, that the nematode is capable of

metabolically detoxifying this material and that the end product of detoxification is toxic to the tree (Bolla *et al.* 1982)."

One of the most effective means of preventing the spread of pine wilt is sanitation. All dead and dying pines should be cut to ground level and the wood converted to chips or the wood burned. The wood should not be stored for firewood, as the adult beetles would emerge from such wood in late spring and summer. Sanitation would greatly reduce the beetle population and thus reduce the spread of the nematode.

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Stewardship of Forested Nature Preserves

Gretchen Bonfert

Illinois Nature Preserves Commission
600 North Grand Ave., West
Springfield, Illinois 62706

ABSTRACT

As the Commission approaches its 30th Anniversary (July 1, 1993), it is appropriate to evaluate how Illinois forests are represented and managed within the Nature Preserves System. Reviewing the size and distribution of protected high quality forested tracts across the state as well as among natural divisions will provide the background for examining how they are managed, the research being conducted within them, and threats to their integrity.

INTRODUCTION

Created by the Natural Areas Preservation Act in 1963, the mission of the Illinois Nature Preserves Commission (INPC) is "to assist private and public landowners in protecting high quality natural areas and habitats of endangered and threatened species in perpetuity, through voluntary dedication of such lands into the Illinois Nature Preserves System. The Commission promotes the preservation of these significant lands, and once dedicated as Illinois nature preserves, oversees their stewardship, management and protection (INPC 1990a and 1990b)."

The Nature Preserves System includes 210 preserves (as of September 26, 1992) encompassing over 30,000 acres, and 10-15 preserves are added to the system every year. Nature preserves range in size from 1/4 acre to 2,000 acres, and are found in over 70 counties. The natural communities protected range from bogs to fens to sand prairies, wet prairies, glades, and an array of forest communities. One-quarter of the state's threatened and endangered species are found in nature preserves and 50% of the occurrences of all listed species are found in nature preserves.

Nature preserve dedication provides the strongest legal protection for land in Illinois, and is inviolable. The Illinois Department of Conservation (IDOC) owns 90 nature preserves, county conservation and forest preserve districts own 43 preserves, and the balance are owned by private individuals, municipalities, not-for-profit organizations, universities, The Nature Conservancy, corporations, cemetery associations, and others. The landowner retains ownership of the land upon dedication and signs a binding legal agreement to never develop the land and to manage it in accordance with the Natural Areas Preservation Act.

Following dedication as a nature preserve, day-to-day issues which nature preserve owners, managers, volunteers, and INPC staff may address include: planning and implementing management activities; evaluating applications for special use permits; and defending nature preserves against threats to their integrity.

The classification system known as the "Natural Divisions of Illinois" was developed twenty years ago as a means of delineating all the different natural regions that exist in the state (Schwegman 1973). There are 14 Natural Divisions and 33 Sections within the natural divisions; each section and division is distinguished by differences in topography, glacial history, bedrock, soils, flora and fauna. It is a primary goal of the Nature Preserves System to ensure that representative examples of all the natural features of Illinois are protected.

This classification provided the framework for the Illinois Natural Areas Inventory (White 1978). Conducted over a three-year period in the 1970's, the participating biologists classified the natural features of the state. The natural communities were described and graded (in terms of an A, B, C, or D).

Over 1,000 areas were identified by the INAI, 610 of them being high quality natural communities. The data from the inventory is managed and updated by the IDOC's Division of Natural Heritage in the computerized Biological Conservation Database (BCD).

While it is not mandatory that a site be identified by the Illinois Natural Areas Inventory (INAI) in order to be considered for dedication as an Illinois Nature Preserve, 189 sites on the INAI have been dedicated as nature preserves. Because one of the Illinois Nature Preserves Commission's goals is to preserve representative natural communities in all of the natural divisions of the state, the INAI is one of the key information sources guiding preservation efforts. For many landowners, the knowledge that their property possesses a high quality natural community catalyzes their efforts to protect it from future disturbance. Nature preserve dedication provides the legal protection to ensure such areas are preserved for, and by, future generations. To date the Nature Preserves System has protected most, but not all, of the extant examples of the presettlement forests of Illinois.

METHODS

The BCD was used to select nature preserves containing high quality forested tracts. Such tracts were defined as those graded as A or B in the Illinois Natural Areas Inventory, of at least 20 acres in size. Therefore, the areas described herein actually represent a subset of all forested lands occurring in the Nature Preserves System (unless otherwise specified, the phrases "high quality forested nature preserves" and "forested nature preserves" refer to this subset described above). The selected nature preserves were then ordered in terms of the types of forests occurring within them, from wet to mesic to xeric.

Approximately 100 applications are submitted annually to conduct research or special activities in nature preserves. Research permits issued from 1989-1992 for the high quality forested nature preserves were reviewed to identify the breadth of research topics investigated.

Increasingly, management activities on nature preserves are planned using three-year management schedules, which are reviewed and approved by the landowner, land manager and the Nature Preserves Commission. Preparing a Management Schedule involves first identifying and prioritizing Management Goals for a preserve (*e.g.*, maintain populations of endangered species, control invasive woody species, prevent motorized trespass). The schedule is designed to accomplish the goals; the schedule is usually prepared to cover the next three years; after this time a new schedule is prepared, keeping in mind the previously determined goals.

The Management Schedule consists of a labelled map and a chart delineating the natural communities on site, the locations of any endangered or threatened species, and specific management objectives (*e.g.*, "control bush honeysuckle in North unit") paired with specific management activities (*e.g.*, "cut and treat stumps with solution of 50% glyphosate"). Also planned are which units of a nature preserve with fire-dependent natural communities will be managed using spring or fall prescribed burning, and in even or odd-numbered years. For each activity the months or season in which the work will occur, and by whom is also stated on the schedule. Often several individuals or organizations share responsibilities at one nature preserve, and turnover occurs in all organizations. The Management Goals and Management Schedule have proven to be an efficient means of involving all parties in goal-setting, clarifying respective stewardship responsibilities, and summarizing concisely the history and status of management activities. Of the 39 high quality forested preserves, 25 have approved management schedules, which were used to identify the most common ongoing management activities in forested nature preserves.

Annual reports are prepared by nature preserve owners and/or managers for the Nature Preserves Commission. Review of these reports, which track illegal activities such as poaching or unauthorized collecting, disturbance, areas needing attention within the preserve, and changes in adjacent land use, provided an overview of potential threats to the integrity of each forested preserve. When a development is proposed near a nature preserve, the Illinois Nature Preserves Commission works with the nature preserve owner, developer, and the IDOC's Endangered Species Protection Program, if threatened or endangered species are involved, to

avoid or minimize the impact of any development on the nature preserve and the species therein. Penalties for damages to a nature preserve range from $1,000 or 364 days imprisonment for a Class A misdemeanor, to up to $10,000 per day for civil penalties.

RESULTS

In Table 1, the 39 high quality forested nature preserves are listed, showing the acreage dedicated as nature preserve, totalling 7,878 acres. This represents 20% of the preserves -- and 25% of the land area -- protected in the Nature Preserves System.

The variety of types of forest communities protected in the high quality forested nature preserves is presented in Table 2. The sites are listed starting with the wettest, most poorly drained floodplain communities, continuing through the moderately well drained uplands, to the dry sand forest communities.

All but two of the 14 Natural Divisions of Illinois are represented by the 39 preserves in Table 1. Table 3 presents six high quality forest communities within five Natural Divisions which are not yet protected in the Nature Preserves System. These areas are scattered in roughly the western half of the state and are known from the Illinois Natural Areas Inventory.

In Table 4, a sampling of ongoing research activities is presented. Twenty percent of all research permits issued annually are for high quality forested nature preserves. The array of topics includes a statewide survey of amphibians and reptiles, butterfly inventories, a survey of fungi, identification of medicinally important species, and studying the impact a proposed tollway may have on a nearby nature preserve.

A prominent aspect of the stewardship of forested nature preserves is controlling invasive woody and herbaceous plant species. The most common vegetation management activity is controlling honeysuckle at 15 nature preserves (bush honeysuckle in northern Illinois; Japanese honeysuckle in southern Illinois), and garlic mustard at 12 preserves. Prescribed burns, one of the most effective management tools for controlling aggressive invasive species, are planned for the spring and fall at eight nature preserves. Also, deer reduction efforts occur annually at four preserves in tandem with research evaluating the impact of deer overpopulation on the natural features of the preserves.

For 13 of the forested nature preserves, attention to the boundaries is needed, such as a survey conducted to clarify an uncertain property line, installation of wire fencing, posting of nature preserve signs, or repair a fence damaged by vandalism. Vehicle trespass has occurred at ten nature preserves, such as snowmobile, off-road vehicles, or motorcycle use (note: in a few nature preserves, special provisions were made during dedication to allow snowmobiling, but it is otherwise not allowed). In some circumstances, posting nature preserve signs and/or installing fencing are adequate deterrents. In other situations, periodic surveillance by volunteers, natural areas managers, law enforcement officials, and possible legal actions are necessary.

At five preserves, trail establishment or repair and bridge replacement are needed. The fastest growing problem area concerning nature preserves is development of adjacent lands. Whether high or low density housing developments or commercial endeavors, possible impacts include siltation, hydrologic alterations, exhaust, noise, and other disturbance.

CONCLUSION

INPC has prepared the following management guidelines for nature preserves: Herbicide Application, Deer Control, Mosquito Control, Vegetation Management Guidelines (for 29 invasive woody and herbaceous species, based upon the experience of natural areas managers in Illinois), and a Guide for Preparation of Management Schedules. These documents are also useful for natural areas management generally. The Illinois Nature Preserves Commission provides nature preserve signs and technical assistance to nature preserve owners as staff and financial resources allow.

There are eighty-five different owners of nature preserves, ranging from private individuals to sizable

public land managing agencies. Consequently, various owners' stewardship capabilities range widely. Natural areas professionals direct the management of their own lands, but also provide guidance and assistance to other nature preserve owners and managers. Thousands of members of The Nature Conservancy's Volunteer Stewardship Network provide site surveillance, brush cutting and prescribed burning on natural areas and nature preserves. Under a cooperative agreement with the Illinois Nature Preserves Commission, over 100 volunteers are licensed to judiciously apply herbicides where invasive plant species are jeopardizing natural communities. Cooperation among all groups and information exchange within and outside Illinois have been key to the successes in natural areas preservation and management during the last 30 years. This cooperation is even more critical for the future preservation of Illinois' natural heritage.

As the Nature Preserves System grows, so grows our knowledge about natural areas management and restoration ecology. Just as rapidly, development and other threats to nature preserves increase. In order to preserve representative examples of all of the natural communities in Illinois, we should work to protect the six forest communities listed in Table 3 which are eligible for consideration by INPC for dedication as nature preserves.

ACKNOWLEDGEMENTS

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Table 1. Nature preserves encompassing high quality forested tracts and acreage dedicated as nature preserve (acres dedicated as buffer not included).

Nature Preserve	Acres
American Beech Woods	21
Beall Woods	333
Black Hawk Forest	107
Black Partridge Woods	80
Bois Du Sangamon	30
Busse Forest	440
Carpenter Park	322
Dean Hills	70
Harper's Woods	40
Harper-Rector Woods	37
Hartley Memorial	40
Heron Pond-Little Black Slough	1861
Horseshoe Lake	492
Iroquois Woods	44
Johnson's Mound	185
Jubilee College Forest	64
Jurgensen Woods	120
Julius J. Knobeloch Woods	35
Laona Heights	20
Lloyd's Woods	105
MacArthur Woods	446
Marissa Woods	25
Massac Forest	245
Matthiessen	86
McMaster Woods	33
Middle Fork Woods	69
Momence Wetlands	72
Myer Woods	20
Norris	62
Ozark Hills	222
Red Hills Woods	32
Rocky Branch	138
Edward L. Ryerson	279
Spitler Woods	146
Starved Rock	582
Stemler Cave Woods	120
Thorn Creek Woods	500
Tomlin Timber	20
Ward's Grove	335
TOTAL	7878

Table 2. Forest types represented in high quality forested nature preserves (natural division in parentheses; Schwegman 1973).

Horseshoe Lake	Wet Floodplain (14b)
Momence Wetlands	Wet Floodplain (4e)
Heron Pond-Little Black Slough	Wet Floodplain/Mesic Upland (13b,14b)
	Dry-Mesic Upland
Julius J. Knobeloch Woods	Wet Floodplain/Dry-Mesic Upland(9a)
Massac Forest	Wet-mesic Floodplain (14b)
Beall Woods	Wet-mesic Floodplain (10ab)
	Wet-mesic Upland
Spitler Woods	Wet-mesic Floodplain (4a)
	Mesic Upland
	Dry-mesic Upland
Carpenter Park	Wet-mesic Floodplain (4b)
	Mesic Upland
	Dry-mesic Upland
American Beech Woods	Mesic Floodplain (10b)
Edward L. Ryerson	Mesic Floodplain (3a)
	Mesic Upland
	Dry-mesic Upland
MacArthur Woods	Mesic Floodplain (3a)
	Dry-mesic Upland
Harper-Rector Woods	Wet-mesic Upland (7a)
	Dry-mesic Upland
Dean Hills	Mesic Upland (9a)
Iroquois Woods	Mesic Upland (4e)
Lloyd's Woods	Mesic Upland (3a)
Bois Du Sangamon	Mesic Upland (4a)
Middlefork Woods	Mesic Upland (10c)
Black Partridge Woods	Mesic Upland/Dry-mesic Upland (3a)
Busse Forest	Mesic Upland/Dry-mesic Upland (3a)
McMaster Woods	Mesic Upland/Dry-mesic Upland (8b)
Johnson's Mound	Mesic Upland/Dry-mesic Upland (3a)
Jubilee College Forest	Mesic Upland/Dry-mesic Upland (7a)
Harper's Woods	Mesic Upland/Dry-mesic Upland (4a)
Starved Rock	Mesic Upland/Dry-mesic Upland (4a)
	Dry Upland
Stemler Cave Woods	Mesic Upland/Dry-mesic Upland (11a)
	Dry Upland
Jurgensen Woods	Dry-mesic Upland (?)
Myer Woods	Dry Upland (4a)
Rocky Branch	Dry Upland (10b)
Ward's Grove	Dry Upland (1)
Norris	Dry Upland (3a)
Mattheissen	Dry Upland (4a)
Black Hawk Forest	Dry Upland (8a)
Marissa Woods	Dry Upland (9b)
Thorn Creek Woods	Dry Upland (3a)
Hartley Memorial	Dry Upland (2a)
Laona Heights	Dry Upland (2a)
Red Hills Woods	Dry Upland (10b)
Ozark Hills	Dry Upland/Mesic Upland (11c)
Tomlin Timber	Dry Sand (6a)

Table 3. Extant high quality forest communities not currently represented in the Illinois Nature Preserves System.

NATURAL DIVISION # AND NAME		SECTION	COMMUNITY TYPE
2b	Rock River Hill County	Oregon	Dry Mesic & Dry Upland
5a	Upper Mississippi River & Illinois River Bottomlands	Illinois River	Wet Mesic Floodplain
5b*	Upper Mississippi River & Illinois River Bottomlands	Mississippi River	Floodplain
7b	Western Forest-Prairie	Carlinville	Dry-mesic Upland
8b*	Middle Mississippi Border	Driftless	Dry-mesic Upland & Wet-mesic Upland
12b	Lower Mississippi River Bottomlands	Southern	Wet-mesic Floodplain

*Natural Division and Section currently unrepresented in the Nature Preserves System by any habitat type.

Table 4. Topics of research in forested nature preserves (1989-1992).

Floristic inventories
Genetic analysis of eastern massasaugas
Archaelogical investigation
Identification of lichens
Population ecology - 3 threatened plant species
Population survey of silvery salamander
Census of higher fleshy fungi
Inventory & water chemistry of bald cypress swamps
Inventory leafhoppers, *Papaipema* spp., butterflies
Impact of sugar maple canopy on oak forests
Deer control
Inventory seep communities
Identify medicinally important species
Comparison of vegetation sampling methods
Evaluate blooming periods of woodland perennials
Propagation of Nuttall's oak
Evaluate proposed tollway threat to preserve
Compare soil/rock movement vs visitor impacts
Study plant regeneration in bottomland hardwoods

STATEWIDE STUDIES:

Treehole mosquitoes, stoneflies, amphibians & reptiles, land snails, deer ticks, butterflies

Vegetative Dynamics of the Prairie/Forest Interface of Cole Creek Hill Prairie

William E. Werner, Jr.

Biology Department
Blackburn College
Carlinville, Illinois 62626

INTRODUCTION

Cole Creek Hill Prairie is located 4 km south of Eldred, Greene County, on the eastern bluffs of the Illinois River valley. This hill prairie occupied about 1.8 ha when it was visited by Evers (1955) in 1950. He named it the South Eldred Hill Prairie, and later renamed it Cole Creek Hill Prairie (Evers and Page 1977).

The Cole Creek Hill Prairie is dominated by *Andropogon scoparius*, but *Sorghastrum nutans* and *Bouteloua curtipendula* are also common grasses. Interesting plants easily found include *Houstonia nigricans, Buchneria americana, Linum sulcatum, Penstemon pallidus, Monarda punctata, Kuhnia eupatorioides, Spiranthes magnicamporum, Gerardia skineeriana*, and *Gentiana quinquefolia*.

This hill prairie is covered by a thick layer of loess. The prairie consists of two parts, like the letter U, with one arm of the U parallel and closest to the Illinois River valley (the west spur), the other arm of the U also parallel to the River valley but farther east (the east spur). The loess was deposited since the Illinoian deglaciation (Evers 1955), and on the steep southern slope of the east spur the loose soil has slumped, exposing snails, indicating that in the years in which the loess was being deposited, the hills were covered with herbaceous vegetation on which the snails were feeding.

The slumps also reveal concretions formed from lime dissolved from the loess by rain water which seeped through the loess deposits and then precipitated out as stone. Such deposits are an indication of the pronounced drainage of the soil, contributing to the droughtiness of the hills, especially the southwest-facing slopes which are exposed to the summer sun and winds. The ends of the hills are unobstructed from the sun and wind because they rise abruptly at least 60 m above the floodplain. The broad floodplain, about 8 km wide, permits the full force of the winds to hit the high slopes. Hence, Evers (1955) states, "It seems probable that a shifting equilibrium was long ago reached between prairie and forest, especially on bluffs with high cliffs. As long as the present topography and climate persist, such hill prairies will remain apparently as they are." This study examines changes in Cole Creek Hill Prairie since 1964.

METHODS AND MATERIALS

In August, 1992, photographs taken in October 1964 were consulted in the field to determine the position of the photographs, and these scenes were rephotographed to document changes of vegetation in the intervening years. Notes were also taken of woody species that are presently invading the hill prairie, and data from annual trips of an ecology class to the prairie were utilized to help interpret changes observed since 1964. Photographs made at intervals between 1964 and 1992 were also consulted.

RESULTS AND DISCUSSION

Since 1964, the present topography has not noticeably changed at Cole Creek Hill Prairie. On the other hand, the area occupied by the prairie has diminished substantially through invasion of trees and shrubs. The western spur is no longer visible from the road at the base of the bluffs, nor from the east spur, due to growth in height of trees at the periphery of the hill prairie and to invasion of woody plants within the prairie. Only the uppermost (northern) segment of the west spur is still prairie, and it is also being invaded by *Juniperus virginiana* that are now about 5 m tall. The eastern and western spurs are no longer connected at the north end.

The eastern spur is still a substantial size (about 1.4 ha), but invasion of the southern end (with the steepest slopes, and most exposed to wind and sun) has been invaded by trees such as *Juniperus virginiana* and *Ulmus rubra*, and by shrubs including *Cornus drummondii* and *Rhus glabra*.

There are several conditions that create opportunities for woody invasion of this hill prairie. Slumping of the soil in the steepest southwest-facing slopes is common. On the top of the hill prairie there are animal activities that create bare soil, especially woodchuck dens. Here *Crataegus* sp., *Ulmus rubra*, and *Juglans nigra* have invaded. A deer trail leads down the crest of both the east and west spurs and causes some exposure of soil.

Human interference has also opened the prairie to invasion by woody species. In the late 1960s, three trenches were dug, about 2 m long, 1 m wide, and 1 m deep. These were made by a local family in search of Indian artifacts, and were not filled in. The trenches were invaded by *Cornus florida, Juniperus virginiana*, *Ulmus rubra* and *Malus ioensis*, and some of the trees are now about 4 m high.

What has caused this change in the dynamics of the forest/hill prairie? In one area near the north end of the east spur, I ran transects across the prairie/forest interface during the years my ecology class visited the area. In this area, with a slope of about 45 degrees, the vegetation at the interface is virtually unchanged. Common species of the forest at this site include *Quercus muhlenbergii*, *Cornus florida, Acer saccharum*, *Rhus aromatica, Ulmus rubra, Cornus drummondii*, *Juniperus virginiana, Ostrya virginiana, Celastrus scandens*, and *Vitis aestivalis*. One *Quercus muhlenbergii* with a trunk diameter of about 65 cm has horizontal limbs that extend out until they touch the hillside. Immediately beyond its branches there is intact prairie. In this same area there are specimens of *Cornus florida* with trunk diameters of about 15 cm, and their limbs also extend laterally to touch the ground, beyond which the prairie is not invaded by woody species. This sudden transition from forest to prairie that has not changed in 28 years indicates stability. Yet elsewhere, at sites where the steep topography (slopes of 45 to 60 degrees) should be expected to repel woody invaders, change to forest seems to be occurring rapidly.

There are several possible explanations for this change. In the past, the hill prairie was pastured, as evidenced by an old barbed wire fence, now on the ground, across the brow of the east spur. It is also possible that fire once occurred with enough frequency to help exclude woody invaders. There has not been a fire on this prairie in the last 28 years. Brush (1944) who in 1820 settled a few kilometers north of Cole Creek Hill Prairie, wrote concerning the bluffs of the Illinois River, "Grass covered the summits, which loomed up above the rock in rounded cones of varied heights, kept denuded of other growth than grass by annual fires that overswept the hills and the prairie ground below." Finally, perhaps the climate in the last several decades has been unusually wet, enough to allow establishment of woody species. However, if this is the case, it would seem it is an unusual event in the climatological cycle, because the west spur of the prairie has been so completely invaded in the past 28 years that it seems very unlikely that most of it could ever again become prairie.

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Exotics of Illinois Forests

John Schwegman

Illinois Department of Conservation
Springfield, Illinois 62701-1787

Illinois forests are negatively impacted by a number of noxious exotic species. Exotic weedy plants have the greatest ecological impact at present, with exotic diseases in second place and exotic animals third. Most of the problem exotic weedy plants are woody; trees, shrubs and woody vines. Of the 21 most serious weeds, 8 are shrubs or small trees, 4 are woody vines, 5 are trees, and only 4 are herbs (Table 1).

Unlike the vast numbers of our alien flora which are accidental introductions thriving in crop fields and disturbed sites, many of the problem weeds of the woods were introduced on purpose. Table 1 shows that 7 were once widely planted for conservation purposes and that 11 are sold by the horticulture trade.

Based on my observations, the potentially most serious weeds of our forests statewide are amur honeysuckle and garlic mustard. Leading regional problem species in northern Illinois include common buckthorn and tatarian honeysuckle, and in southern Illinois, Japanese honeysuckle and wintercreeper.

Efforts at control have concentrated on control through management and prohibition of selling and planting in the State. The development of biological controls offers hope, but is not under way for any of these species at present. Management controls include mechanical removal such as cutting or pulling, girdling, treatment with herbicides, and prescribed burning. While these help maintain the forest managed for nature preservation, most Illinois forests are not managed for this purpose and continue to deteriorate.

Biological controls, which unite problem weeds from foreign lands with the diseases and insects that control their numbers in their native habitat, hold the best hope for saving all of our woods from the most serious pests. It is an expensive process costing about 1 million dollars in research and development and takes at least 9 years to complete. However, when weighed against the costs of chemicals and manpower for management controls, it is very cost effective.

Biological controls are developed by the U.S.D.A.'s Agricultural Research Service, mostly for agricultural pests. We should all urge our representatives in Congress to support biological control development for wildland weeds. Our first priorities should be amur honeysuckle, garlic mustard, Japanese honeysuckle, and common buckthorn.

Illinois' only effort at control through regulation is the Illinois Exotic Weed Act which prohibits the sale or planting of multiflora rose, Japanese honeysuckle, and purple loosestrife. The latter species is a wetland weed that does not invade forests. Efforts to amend the Act to prohibit amur honeysuckle, autumn olive, and crown vetch (a weed of open habitats) have failed. Opposition from nursery interests have prevented the Illinois Legislature from adding them to the prohibited list.

There are many other potentially serious weeds getting started in Illinois forests at present, but the ones listed above are the main problems now. A serious weed of eastern forests that may eventually get to Illinois is mile-a-minute (*Polygonum perfoliatum* L.).

The principal exotic diseases affecting Illinois forests are Dutch elm disease, butternut canker, and American chestnut blight. Dutch elm disease entered the United States at Cleveland, Ohio, on unpeeled veneer logs in 1930 and had spread nationwide by 1975. Its fungal spores are spread by bark beetles. It has killed many of the American elms in Illinois' forests, being especially devastating in northern Illinois.

Butternut canker was first identified in Wisconsin in 1967 and is now killing butternuts throughout the

range of the species. Many Illinois butternuts have died, but thanks to the scattered nature and low density of this tree in our forests, some of our trees still survive. The spores of this fungal disease are spread by the wind.

The American chestnut blight was introduced to the United States in 1903 in a shipment of Asiatic chestnut nursery stock. It has now top-killed nearly all native American chestnuts. Some root sprouts still persist a few years before being reinfected and killed back by the fungus, but in effect our tree has been eliminated as a component of the American forest. Illinois' only known native chestnut stand, located in Pulaski County, may have been killed by this disease. Isolated trees planted in our forests still persist, but it seems that the fungus eventually reaches even the most remote trees and kills them.

The most serious disease that may affect our forests in the near future is dogwood anthracnose. This exotic Asian fungal disease was first noted around New York City in 1977. It has since killed up to 80 percent of the flowering dogwood trees in many areas of the Appalachians, and is headed our way. It was last noted in central Tennessee, spreading toward southern Illinois. Flowering dogwood is a very important and beautiful small tree of the southern two-thirds of the State. Its loss or decline would have a major detrimental effect on our forests.

Other exotic diseases that may eventually impact our forests are white pine blister rust and beech bark disease. Both are fungal diseases.

The principal exotic animal threatening Illinois' forests is the gypsy moth. A few outbreaks have occurred in northeastern Illinois, but to date they have not had the devastating effect on our forests that they have had in the northeastern states. There, large numbers of caterpillars defoliate and eventually kill hardwood forests.

If Illinois' forests are to survive, government must get control of future pest introductions and effectively address the problem of controlling the species we already have. Congress' office of technology assessment is currently conducting a study of how this might be accomplished. Their report is scheduled for release in February 1993. Everyone interested in this problem should get a copy and let their elected representatives know that they want to see this problem addressed.

Table 1. Principal exotic weeds of Illinois forests.

Woody Species		
Amur honeysuckle#	*Lonicera maackii* (Rupr.) Maxim.	Mesic habitats, statewide
Japanese honeysuckle*#	*Lonicera japonica* Thunb.	Mesic habitats, south
Common buckthorn	*Rhamnus cathartica* L.	Mesic forests, north
Tatarian honeysuckle*	*Lonicera tatarica* L.	Mesic, north half
Autumn olive#	*Elaeagnus umbellata* Thunb.	Open habitats, statewide
Tall hedge*	*Rhamnus frangula* L.	Wet to mesic habitats, north half
Wintercreeper*	*Euonymus fortunei* (Turcz.) Hand.-Maz.	Mesic habitats, south half
Multiflora rose#	*Rosa multiflora* Thunb.	Mesic habitats, throughout
Winged wahoo*	*Euonymus alatus* (Thunb.) Sieb.	Mesic forests, throughout
Oriental bittersweet*	*Celastrus orbiculatus* Thunb.	Forests, statewide
Black locust#	*Robinia pseudoacacia* L.	Mesic to dry, throughout
Kudzu#	*Pueraria lobata* (Willd.) Ohwi	Mesic forest edges, south
Tree of heaven*	*Ailanthus altissima* (Mill.) Swingle	Mesic disturbed, throughout
Privet*	*Ligustrum obtusifolium* Sieb. & Zucc.	Woods, throughout
Goldenrain tree*	*Koelreuteria paniculata* Laxm.	River bluffs, south
Osage orange#	*Maclura pomifera* (Raf.) Schneider	Low woods and river banks
Amur maple*#	*Acer ginnala* Maxim.	Woods, throughout
Herbs		
Garlic mustard	*Alliaria petiolata* (Bieb.) Cavara & Grande	Forests in north two-thirds
Eulalia	*Microstegium vimineum* (Trin.) A. Camus	Low woods, south
Chinese yam	*Dioscorea batatas* Dcne.	Woods and brushy areas, south
Moneywort	*Lysimachia nummularia* L.	Wetlands throughout

*Plants currently in the horticulture trade.
#Plants once promoted for wildlife or soil conservation purposes.

Native Actinorhizal Plants of Illinois

Jeffrey O. Dawson and Mark W. Paschke

Department of Forestry, University of Illinois
Urbana, Illinois, 61801

ABSTRACT

Actinorhizal plants are non-legumes nodulated by the symbiotic actinomycete *Frankia* that fixes atmospheric nitrogen. Actinorhizal plants occur on nitrogen-poor sites including sandy and gravelly soils, raw mineral soils, and wet soils. Virtually all known actinorhizal plants are trees or shrubs occurring in 25 genera and eight families of angiospermous plants. There are six native species of actinorhizal plants in Illinois. Four of these six species (*Alnus incana* ssp. *rugosa* (DuRoi) Clausen, *Ceanothus herbaceous* Raf., *Shepherdia canadensis* (L.) Nutt., and *Comptonia perigrina* (L.) Coult.) are listed as endangered in Illinois (Herkert 1991) but are common elsewhere. Actinorhizal *Alnus serrulata* (Ait.) Willd. (hazel alder or smooth alder) is a multistemmed shrub or small tree that is typically found in southern Illinois along stream banks on coarse, rocky soils sorted by periodic floods. *Alnus incana* ssp. *rugosa* is found on moist soils at a few locations in northern Illinois. The widespread actinorhizal plant *Ceanothus americanus* (New Jersey tea or redroot) and *C. herbaceous* (inland *Ceanothus*) are small shrubs that occur on drier sites in Illinois including native prairies, savannas, and open oak woodlands. *Shepherdia canadensis* (L.) Nutt. and *Comptonia perigrina* occur on dry sandy soils in a few restricted locales.

INTRODUCTION

Frankia is the genus of actinomycetes that is able to nodulate the roots of plants belonging to 8 diverse dicotyledonous plant families and 25 genera (Table 1). These plants are termed actinorhizal plants. *Frankia* fixes atmospheric nitrogen symbiotically with these plant hosts. The word "actinorhiza" is formed from the base terms actino for the actinomycete *Frankia* and rhiza from the Greek for root. It is notable that all of these actinorhizal host plants are woody with the exception of two species of herbaceous perennials in the genus *Datisca*. Two genera, *Arctostaphylos* and *Rubus*, have been included in past lists of *Frankia*-nodulated plants (Bond 1967, 1983) but are now discounted as host genera because nodulation could not be confirmed (*i.e.* Stowers 1985).

Frankia are filamentous organisms that produce sporangia and thick-walled, spherical structures termed vesicles. Sporangia and vesicles are derived from hyphae. Sporangia contain many spores and are produced in culture and in some nodules of certain host genera. Vesicles are born on short branches attached to the hyphae and contain nitrogenase, the enzyme used to convert atmospheric dinitrogen to ammonium. The thick walls restrict the diffusion of oxygen into vesicles, thus protecting nitrogenase from the deleterious effects of atmospheric oxygen.

The Natural Occurrence of Actinorhizal Plant Associations

Actinorhizal plants are found primarily on nitrogen-poor sites such as sandy and gravelly soils, raw mineral soils, and wet soils. They occur in forest, swamp, riparian, shrub, prairie, and desert ecosystems. In temperate and cool climates actinorhizal plants seem to fill the ecological niche occupied by woody legumes in the tropics. Actinorhizal plants frequently occur as pioneer vegetation at early stages of plant succession following such disturbances as flooding, fires, landslides, glacial activity, and volcanic eruptions.

For example *Alnus*, *Hippophae*, and *Dryas* species were probably important in the initiation of soil formation immediately following the retreat of continental ice sheets over vast areas of Europe, Asia, and North America (Bond 1983). Similarly *Alnus rubra* Bong. was a major colonizer of mud flows covered with ash resulting from the recent eruption of Mount St. Helens volcano in the state of Washington, USA.

Exotic actinorhizal plants can become readily naturalized and sometimes weedy in disturbed landscapes. Examples include the widespread naturalization of *Casuarina* spp. in southern Florida, *Elaeagnus umbellata* Thunb. in the eastern US, and *Elaeagnus angustifolia* L. in the western US and Canada. *Elaeagnus umbellata* has been declared noxious by weed control agencies in some areas of the eastern US, and hence is locally subject to eradication efforts and planting bans. Actinorhizal *E. umbellata* is spread readily by birds which relish their fruit and is invasive on disturbed sites in Illinois. Consequently there are State restrictions on its production and use.

Many actinorhizal plants persist in the understory of open forest stands, particularly on excessively wet or dry sites, or as dominant species in stable plant communities. Examples include *Myrica cerifera* L. which is a common understory shrub in stands of *Pinus taeda* L. and *Pinus elliotii* Engelm. on sandy soils of the coastal plain in the southeastern U.S., *Cercocarpus* spp. in the understory of *Pinus ponderosa* Laws. stands in semi-arid regions of western North America, and stands of *Casuarina glauca* Sieber that dominate brackish coastal swamps in southeastern Australia. In Illinois *Ceanothus americanus* L. is characteristic of oak savannas and open oak woodlands.

Other actinorhizal plants that occur in forest ecosystems are *Coriaria* spp., which precedes forest vegetation in New Zealand; *Dryas* spp. and *Alnus* spp., which colonize raw glacial till in Alaska prior to succession by spruce; *Purshia* spp., which occurs as an understory plant in open pine stands of western North America; *Shepherdia* spp. and *Alnus* spp. on poor sites with aspen and spruce in the Rocky Mountains; *Comptonia perigrina* (L.) Coult. and *Alnus viridis* ssp. *crispa* (Ait.) with jack pine on sandy soils in eastern Canada; and *Ceanothus*, an indigenous North American genus that occurs primarily on dry sites, with a variety of forest trees and other vegetation (Dawson 1983).

In addition, actinorhizal plants are cultivated as ornamental, wildlife, timber, fuelwood, pulpwood, reclamation, nurse and windbreak plants (Dawson 1986). Others await culture and domestication. It is most probable that actinorhizal plants, so ubiquitous on poor soils, contribute substantially to the nitrogen economy and productivity of many ecosystems.

The Occurrence of Native Actinorhizal Plants in Illinois

There are six native species of actinorhizal plants in Illinois. Four of these six species (*Alnus incana* ssp. *rugosa* (DuRoi) Clausen, *Ceanothus herbaceous* Raf., *Shepherdia canadensis* (L.) Nutt., and *Comptonia perigrina*) are listed as endangered in Illinois (Herkert 1991). Although rare in Illinois, these four species are common elsewhere.

Comptonia perigrina (sweetfern) and *Shepherdia canadensis* (buffaloberry) are small shrubs that characteristically occupy infertile sandy soils. *Shepherdia canadensis* occurs on sandy bluffs and in sand dune plant associations near Lake Michigan in northeastern Illinois and is perhaps the rarest shrub in the state. *Comptonia perigrina* is restricted to sandy acidic soils in northeastern Illinois. Both species are more common on similar sites further north in the Lake States.

Alnus serrulata (Ait.) Willd. (hazel alder or smooth alder) is a multistemmed shrub or small tree that is typically found in southern Illinois along stream banks on coarse, rocky soils sorted by periodic floods. Consequently the typical soils in which this alder occurs are low in organic matter and nitrogen. This species is the common alder of the southeastern U.S.

Ceanothus americanus (New Jersey tea or redroot) and *C. herbaceous* (inland *Ceanothus*) are small shrubs that occur on drier sites in Illinois including native prairies and open oak woodlands. The genus *Ceanothus* is endemic to North America and the center of diversity for this genus is in the western U.S. where more than fifty species are known. Only

four native *Ceanothus* species occur east of the Mississippi River in the U.S. *Ceanothus microphyllus* Michx. is the easternmost *Ceanothus* species and occurs on well drained pinelands in southern Alabama and Georgia south through Florida and the Bahamas. A single extant population of *Ceanothus sanguineus* Pursh occurs in northern lower Michigan, far removed from the northern Rockies and Cascade Range where it is a common gap species. It is interesting to note that our native *Ceanothus americanus* occupies similar habitats and is more closely related taxonomically to *Ceanothus sanguineus* than to Illinois' other native - *Ceanothus herbaceous* (Coile, 1988).

Ceanothus herbaceous (*Ceanothus ovatus* Desf.) is more typical of drier short grass prairies to the west and north. In Illinois this species is not common, but is associated with sandy soils along the Mississippi River near the driftless area in northwestern Illinois and the Lake Michigan dunes. It occupies drier sites than those typical of the most common and widespread actinorhizal plant in Illinois, *C. americanus*.

There are two recognized varieties of *Ceanothus americanus*, *C. americanus* var. *intermedius* (L.) Trel and *C. americanus* L. var. *pitcheri* T. & G. Both of these varieties are reported to occur in Illinois. Variety *pitcheri* is recognized by its obtuse leaf tips and hairy upper surfaces, while variety *intermedius* has nearly glabrous upper surfaces and acute to acuminate leaves. There appears to be considerable ecological variation in leaf morphology in *C. americanus* and we have noticed considerable morphological plasticity in our greenhouse specimens grown under different moisture regimes. *Ceanothus americanus* is easily confused with *C. herbaceous*, however, *C. herbaceous* can be readily distinguished by its leafy peduncles and terminal inflorescences, while *C. americanus* possesses naked peduncles and a combination of terminal and axillary inflorescences.

In dry soils where Illinois' two native *Ceanothus* species occur, periodic soil moisture deficits likely limit mineralization of organic nitrogen, hence its availability in soil solution. In prairies, savannas, and open oak woodlands where these shrubs are found, root competition for water and nutrients is often severe, creating a dearth of available nitrogen even where organic nitrogen levels are relatively high. The ability of *Ceanothus* to fix nitrogen in association with *Frankia* gives these shrubs a competitive advantage on these nitrogen-limited sites. *Ceanothus* is able to persist after fires and heavy browsing because it possess an enormous taproot and resprouts rapidly. Attempts at removal of mature plants from prairie soils by early settlers, and the ability of its taproot to abruptly stop sod-busting plows drawn by teams of oxen, resulted in *Ceanothus* earning the name "rupture root". The name New Jersey tea was given to *C. americanus* during the American revolution when the leaves were used as a patriotic substitute for imported teas. *Alnus incana* ssp. *rugosa* (*Alnus rugosa* (DuRoi) Spreng.), known as speckled alder, is a shrub or small tree that usually occurs in wetlands where often saturated soils have low oxygen levels and cooler temperatures which both retard mineralization of organic nitrogen. Cool, wet soils can have low levels of available nitrogen even where the organic nitrogen pool is large. *Alnus incana* ssp. *rugosa* is found only in the northeast corner of Illinois where it is an uncommon but locally abundant shrub of swamp and bog communities. This species probably occupied a larger range in northern Illinois prior to drainage of wetlands for agriculture. *Alnus incana* ssp. *rugosa* is known as the common "tag alder" in the northeastern and northern U.S. where it occurs along streams, lakes and in marshes. This species often occurs in dense, impenetrable thickets that are the bane of fishermen, being difficult to walk through and snaring many artificial flies and lures cast by anglers.

Nitrogen Contributions

One of the primary benefits of the natural association of actinorhizal plants with other plants is their input of fixed nitrogen to soil. Nitrogen accumulation rates ranging from 60 to 320 kg per ha per year have been estimated for *Alnus* spp. (Newton *et al.* 1968; Tarrant and Trappe 1971). Estimates of the amounts of nitrogen that actually become available to associated plants through mineralization of organic material in stands containing actinorhizal plants range from 48 to 185 kg per ha per year for stands with alder (Daniere *et al.* 1986; Paschke *et al.* 1989) and up to 236 kg per ha per year for a plantation containing *Elaeagnus umbellata* (Paschke *et al.*, 1989). Estimates of

nitrogen mineralization more accurately reflect the influence of actinorhizal plants on soil nitrogen fertility than estimates of total nitrogen input.

At a montane cirque lake in California, *Alnus tenuifolia* Nutt. shrubs growing along the lakeshore and the banks of streams in the lake's watershed were probably a major source of nitrogen to the lake ecosystem, which included a productive trout fishery (Goldman 1961). Increased photosynthetic activity of the lake's phytoplankton and a better development of the aquatic plant Isoetes were associated with the presence of *Alnus* along the shore. The cold streams that support trout, and that are important for anadromous salmon spawning in the headwaters of larger rivers, are often infertile. It is possible that streamside alders are important sources of nitrogen to planktonic organisms at the beginning of the food chain for salmon, trout, and their fry. The importance of riparian alder vegetation to commercial salmon fisheries and sport fisheries has not been assessed. It is likely that riparian and wetland alders native to Illinois also contribute substantially to the nitrogen economy of their associated terrestrial and aquatic ecosystems.

Illinois' actinorhizal plants are interesting components of our native flora with a little-appreciated role as nitrogen-fixing soil improvers. Apart from their value as elements of our greatly-diminished native flora, many of these plants have potential for use as ornamental plants and in prairie, savanna, and forest restoration. For example, *Ceanothus americanus* possesses large nectaries that attract and support nectar-feeding insects including some rare moths and butterflies of native prairie and savannah ecosystems. Swink and Wilhelm (1979) point out that *C. americanus* "is one of the best species in our area, when in bloom, for the collection of interesting insects". Specimens of *C. americanus* in our collection annually attract a diversity of insects despite the barriers imposed by a greenhouse designed to exclude insects.

Because of their ability to fix atmospheric nitrogen in plant communities where nitrogen is scarce, actinorhizal plants are important sources of nitrogen-rich forage for herbivores. Most actinorhizal plants can sustain high levels of browsing, and some actinorhizal species exhibit stimulated growth when defoliated (Bilbrough and Richards 1989).

Increased knowledge of actinorhizal plants and their ecological characteristics should aid in our management of these species in their native Illinois habitats, in recreated and restored natural areas, as well as in cultivation. *Ceanothus americanus* seedlings are produced by the Illinois Department of Conservation Mason County Nursery for planting on state lands and are also available from private nurseries. Other actinorhizal species can also be obtained from private nurseries. Illinois' actinorhizal plants merit efforts to maintain them in their natural settings and to cultivate them in the urban and rural landscape.

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Table 1. Currently known actinorhizal plant families and genera [adapted from Bond (1983) and Baker and Schwintzer (1990)].

Family	Genus	Number of species
Betulaceae	Alnus	35
Casuarinaceae	Allocasuarina	54
	Casuarina	16
	Ceuthostoma	2
	Gymnostoma	18
Coriariaceae	Coriaria	16
Datiscaceae	Datisca	2
Elaeagnaceae	Elaeagnus	38
	Hippophae	2
	Shepherdia	2
Myricaceae	Comptonia	1
	Myrica	28
Rhamnaceae	Adolphia	2
	Ceanothus	51
	Colletia	4
	Discaria	5
	Kentrothamnus	1
	Retanilla	2
	Talguenea	1
	Trevoa	2
Rosaceae	Cercocarpus	5
	Chamaebatia	2
	Cowania	3
	Dryas	3
	Purshia	2

Fighting for Life: A Plan for Endangered Plants

Robert H. Mohlenbrock

Southern Illinois University
Carbondale, Illinois 62901

Most of us are familiar with these recent news items: "Tropical rainforests amounting to the size of Pennsylvania are being destroyed each year." "Seventy plant and animal species disappear each day." "One million species are at risk of extinction by the end of this century."

One you may not have heard, reported by Dr. Al Gentry of the Missouri Botanical Garden, is that a mountain ridge in Ecuador smaller than 20 square miles contained 96 species of plants known from no other place in the world. It was completely destroyed during a timber operation. This is frightening news.

Since I began talking a few minutes ago, another organism probably became extinct some place in our world; ten more acres of tropical rainforest were destroyed. The message about our natural resources is an urgent one. Waiting for the problem to go away will not happen. We must act, all of us, to preserve natural diversity.

Most of us are or should be appalled by the statistics just given, but to most of us, it just doesn't hit home because we don't really experience it. We go about our daily activities in the same world we had the day before. We see destruction of habitats in Illinois in the building of roads or the clearing of land for development, in mining and other activities, but we are not cognizant of any species becoming extinct before our eyes.

Yet the mass destruction of natural habitats and their species by us will eventually engulf us if we continue to permit isolated patches of natural areas and their species to be destroyed.

That is why I chose to talk today about some conservation efforts being made at the international level. In an effort to deal with conservation problems around the world, the *International Union for the Conservation of Nature* (IUCN), was created in 1948. The organization is today considered to be the leading international conservation body. With headquarters in Switzerland, the IUCN is like a United Nations of Conservation, with 119 member nations.

The stated purpose of the IUCN is to develop strategies for coping with preservation of our natural heritage while utilizing efficiently our resources. The organization is run by a handful of paid staff and hundreds of volunteers, such as myself.

I would like to give you an organizational diagram of the IUCN and show you where my committee's current work fits in. The leading person is the *Director General*, and he coordinates three major areas of activity.

The first area is the *Conservation for Development Center*. This unit sets up offices in countries that ask for assistance in designing and carrying out conservation projects. At the present time, there are regional offices established in 12 nations.

The *Conservation Monitoring Center* receives all pertinent data and computerizes them. Data are accepted for animals, plants, protected areas, and wildlife trade. I feed data on endangered plants of North America into this Center.

The largest unit is the *Technical Division*, staffed completely by volunteers. This division prioritizes conservation needs and designs and carries out action plans. There are six commissions within the Technical Division.

It is the *Species Survival Commission* (SSC) that I wish to concentrate on. The SSC is IUCN's primary source of the scientific and technical information required for the maintenance of biological diversity through the conservation of endangered and vulnerable species of fauna and flora.

There are 90 committees in the SSC. One of the last ones to be formed was the *North American Plants Group*, and I have the honor of being appointed the chairman of this group.

Of the 90 committees, 74 are devoted to various groups of animals—wolf, bear, otter, etc. Of the 16 plant groups, some are devoted to a particular group of plants, some to a particular region. Thus, there are orchid, fern, palm groups, etc., as well as a plant committee for China, Australia, South American, North America, *etc*.

As chairman of the North American Plants Group, I have selected a committee of volunteers to assist in planning and carrying out our projects. I attend an annual SSC meeting selected for somewhere in the world to give progress reports on our projects. Every three years I am required to attend the IUCN General Assembly where I not only give a triennial report and plans for the next triennium, but also participate in the lengthy plenary sessions that last two weeks. It is at these sessions that major world conservation strategies are proposed, debated, and voted upon.

I have a committee of 18 persons scattered around North America that I present project proposals to for their review. We are currently engaged in several projects to assist in the protection of plant diversity in North America.

I would like to give you some idea of our committee's activities by describing briefly our projects.

I. <u>Centers for Endemics in North America</u>

An endemic species is one that is confined to a specific and therefore usually limited area. There are several areas in North America inhabited by an exceptionally high number of endemic plants. Since endemics, by virtue of their restricted ranges, are frequently endangered species, a study locating and defining the endemic areas of North American plants is appropriate for our committee. We have identified major and minor areas of endemics.

The *Florida Scrub* is an area in central Florida, particularly associated with a range of hills near Lake Wales known as the Lake Wales Ridge. In what is virtually a dry desert habitat, the Florida Scrub consists of white or yellow surface sand that supports rather sparse vegetation. Sand pines usually stand above a mixture of saw palmettos and various species of scrub oaks.

In the understory is an unusually high number of endemic plant species that are adapted to growing in this mineral-poor substrate. In one field near the community of Lake Placid, I was able to count nine different endemic species. These include a wild plum (*Prunus geniculata*), a few wild mints including *Diceradra immaculata*, a type of golden aster (*Chrysopsis floridana*), a morning-glory (*Bonamia grandiflora*), and others. Most of the Florida Scrub is still in private ownership, and the habitat is being destroyed rapidly because of the population increase in that part of Florida. This is a key area that we are zeroing in on for protective action.

The *Roan Mountain Massif* is a gorgeous mountain in the Blue Ridge system that straddles the North Carolina-Tennessee state line. Although reaching an elevation of only 6,245 feet, and certainly not above treeline, a treeless area, known as a *bald*, has developed on top of Roam Mountain. The popular attraction here is the magnificent rhododendron garden, dominated by native Catawba rhododendron (*Rhododendron catawbiense*). But further exploration of the massif reveals other species endemic to the area, including the dwarf Roan Mountain goldenrod (*Solidago roanensis*). While part of the mountain receives some protection from the Pisgah and Cherokee National Forests, other parts, including the habitat for the goldenrod, are not as yet in a special management zone.

The *Uinta Basin* occurs in the extreme eastern part of Utah and across into adjacent Colorado. The basin is a huge natural depression surrounded by a rim dominated by the crest of the Uinta Mountains to the north and the Book Cliffs to the south. The ruggedly beautiful Green River bisects the area as it passes through Desolation Canyon.

The Uinta Basin is noted for its shale outcrops and sandstone formations. Most of the region is of the mixed desert and shrub type, although the area has sometimes been described as a badland type of habitat. Mineral resources are rich in the Uinta Basin, with large supplies of natural gas in the floor

of the basin, great deposits of coal, and oil-rich shale. Because of this, mineral exploration is a continuous hazard for the plants that occur in the basin. The shale is so rich in oil that sometimes oil virtually drips from the plant when it is removed from the soil. Several endangered endemic species occur here, and although they are on public land administered by the Bureau of Land Management (BLM), the BLM does not own the mineral rights or have they set aside any of the basin for preservation. Some of the endemic plants found here are the debris milk vetch (*Astragalus detritalis*), Graham's penstemon (*Penstemon grahamii*), the shale phacelia (*Phacelia argillacea*), and the Townsend daisy (*Townsendia condensata*). Preservation of this endemic center is critical.

Other areas of endemism of concern to our committee include the Nordhouse Dunes on the eastern shore of Lake Michigan, Sycamore Canyon on the Arizona-Mexico border west of Nogales, the Coral Sand Dunes of southern Utah, the Florida Keys, the Eureka Sand Dunes of eastern California, the Amargosa Valley near Death Valley, San Clemente Island, and a part of the volcanic Mauna Kea in Hawaii.

II. Reputed Extinct Plants of North America

Scarcely anyone paid much attention when an occasional species of plant became extinct in North America. After all, a whole ark of dinosaurs became extinct from natural causes, so why should one become alarmed if an occasional plant bit the dust. Organisms will become extinct sooner or later, anyway.

But with the environmental revolution, along with passage of the Federal Endangered Species Act in 1973, we perhaps began to have a feeling of guilt when we realized that most extinctions in modern times have been caused by our own interventions. In addition, more and more scientific data were beginning to tell us that there may be some potential in every species, perhaps as a drug or medicinal plant, as an ornamental, as a source of fats or oils, or whatever. It behooved us, then, to try to preserve every living species and its gene pool so that scientists could have a chance to understand fully each species.

Suddenly the word *extinction* became important—and scary. A book entitled *Extinction is Forever* made clear the finality of this process.

One of the charges to our SSC committee is to do everything possible to prevent the extinction of our plant species. One way to approach this is to learn from history. If we could determine what caused the extinction of a certain species in the past, perhaps we could avoid a similar fate for some current plants.

Our committee chose to make a study of the extinct plants of North America, primarily with the hope of learning some of the causes of extinction. As an added interest, we wanted to see if these plants were really extinct through intensive field searches.

When the U.S. Fish and Wildlife Serve was asked by Congress in 1976 to evaluate the status of the nearly 21,000 native species of plants in North America, it suggested that about 125 plants which had not been reported for a number of years might indeed be extinct. This is the basic list we started from in our study of possibly extinct plants.

For each plant we study the literature and the herbarium to find information concerning past collections and locations. We record all the pertinent information, including its precise locality, its habits, when it flowers, etc. A trip to the field is then made to try to relocate the plant, or at least to find what may have been its habitat. In many cases, we do not have precise localities recorded. In essence, it is like looking for a needle in a haystack.

The results to date have been interesting, exciting, sometimes frustrating, sometimes gratifying. Let me give you a few case studies.

Most famous of the extinct plants is *Thismia americana*. This miniature species was found in the Chicago area between 1912 and 1914 and not seen since. Intensive searches for this plant by nearly 300 plant enthusiasts the last two years have failed to turn up this elusive species.

Equally famous is the Franklin tree, *Franklinia altamaha*. John and William Bartram, two of our nation's first naturalists, were looking for new plants that would make good ornamentals. When they

found them, they would sell seeds and other plants parts to England where they would be introduced into cultivation. In 1765, while exploring along the banks of the Altamaha River near Fort Barrington, Georgia, John found a colony of beautiful flowering trees. These trees, related to camellias, had flowers almost as pretty. On a second visit in 1776, the naturalists did their usual thing. They collected parts of the plants, including seeds. And it is a good thing they did. Although Reverend Moses Marshall saw the same colony of Franklin trees in the wild in 1970, and John Lyon saw them on June 1, 1803, no one has ever seen this plant in the wild since. Although the forest still exists, apparently the Franklin tree does not. Seeds sent to England sprouted, however, and the plant has been maintained as a cultivated species ever since. We are unable to propose why it suddenly vanished and why it hasn't been found in other similar-appearing woods.

Nichol's Devil's-head Cactus is a foot-tall, blue-green species that was discovered in the mountains west of Tucson, Arizona, in 1930. The plant was apparently forgotten about and no one had reported seeing it when I decided to look for it with my family one year during preparation of my book, *Where Have All the Wildflowers Gone?*. We knew the species had been found on a mountain near the tiny mining town of Silver Bell. Selecting one of many possible mountains surrounding the town to begin our search, we set out for the side of the mountain. There was the long lost cactus! We were able to remove a plant from the potentially extinct list.

On the same trip, we attempted to relocate a small false buckwheat, *Eriogonum gypsophilum*, that had been found in gypsum-bearing soils in southern New Mexico on August 6, 1909. Having fairly good directions from the original collection, we headed for what we thought was a likely spot, and there it was! Although we didn't find very many of them, we had the evidence to remove it from the extinct list.

Near the turn of the century, a different kind of pondweed was found living in the water of Blackwater Creek in the vicinity of Pensacola, Florida. Considered to be a new species, it was called *Potamogeton floridanus*. Despite repeated efforts to relocate it, no one could find this aquatic. The U.S. Fish and Wildlife Service declared it extinct in 1976. While studying the plants of the Florida Panhandle, Gerry Wilhelm waded into a tributary of Blackwater Creek and pulled out a pondweed. After thorough study of the plant in the laboratory, Gerry realized he had rediscovered the Florida pondweed! Another success story, and there have been a few of them.

When I wrote *Where Have All the Wildflowers Gone?* in 1983, my closing chapter decries the extinction of plant species. Quoting from Chapter 9, I commented: "*Thismia* is not alone as an extinct plant. Many others have not been seen for years and are presumed to be extinct. That's too bad, because I would like to have seen *Hechtia texensis*, a prickly member of the pineapple family that was found on dry limestone bluffs in the Big Bend area of Texas and not seen since."

"Wouldn't it be nice to go to the Undive Falls in Yellowstone National Park and see the showy rock cress, *Arabis fructicosa*? Nobody has been able to do so since 1899. Or go to Klamath Falls in Oregon and see Applegate's milk vetch, *Astragalus applegatii*? It was found in 1927 and again in 1931, but not since."

I am happy to report that this last statement is no longer true. A few years ago, botanists from Oregon rediscovered Applegate's milk vetch alive near Klamath Falls.

III. <u>Red Data Books</u>

Despite what I believe is the significance of the centers of endemism and the extinct plants projects, our major current study and work are directed toward the preparation and publication of the *Red Data Books for North American Plants*. The ultimate goal of each SSC group is to publish one or more Red Data Books which contain an account of the most endangered species of a particular group or area. Only a few have been done to date. These books are written after detailed study. They provide the latest information about an endangered species—what it looks like, where it is found, how many are left, what are the threats to it, and what can be done about it.

Our initial task was to determine what species to include in our Red Data Books. We are fortunate

in North America to have several organizations and individuals interested in and working on endangered species, and we are using this network to assist us in the Red Data Books project.

We have drawn up a list of native plant species most in danger of becoming extinct. Because the list became so voluminous, we decided to publish two Red Data Books--one for the plants of Hawaii, and the other for the rest of North America. Unlike previous Red Data Books, ours will be fully illustrated with line drawings of each species, as well as color photographs. Let me give you a few examples of plants we will be including in the Red Data Books.

The Pitkin Marsh Paintbrush is perhaps the most critical living species in North America. It occurs only in Pitkin Marsh, in southern California, where it displays beautiful spikes of yellow flowers. There is only one plant known for this species. It consists of several stems, all from the same rootstock. Its dilemma is that it does not reproduce. Fruits and seeds are not formed. Attempts to take cuttings or to grow this plant in tissue culture have failed. Unless some mechanism is found to induce reproduction of some kind, this plant is doomed. Researchers are working round-the-clock to find a way to save it.

Raven's Manzanita is a mounded shrub growing at The Presidio, a military park just outside the Gold Gate Bridge in San Francisco. There is only one living specimen in the wild, although two previously known wild populations have been destroyed. This plant does not produce seeds, but it does respond to cuttings. Plants grown from cuttings can now be seen in a few gardens.

A few summers ago, my wife and I were exploring in the LaSal Mountains in eastern Utah, researching the area for my series in the *Natural History* magazine. I learned from the Manti-LaSal National Forest headquarters that the very rare and peculiar Spineless Hedgehog Cactus had recently been found in the LaSal Mountains. This cactus, nearly devoid of spines, had originally been found in the mountains across the state line near Paradox, Colorado. With general directions, we set off for the ridge in the LaSal Mountains where the cactus reputedly grew. After considerable searching, we spotted one beautiful clump of this spineless hedgehog.

The Green Pitcher Plant is one of those strange species of flowering plants that derives some of its nutrition from living organisms that it is able to trap. Because of this unique feature, they are often sold as novelties. As a result, most of them are becoming scarce in the wild. Perhaps the rarest of them all is the green pitcher plant, known from a very limited area in Alabama and adjacent Georgia.

A few other species to be highlighted in the Red Data Books are the Magazine Mountain pipewort, a delicate semi-aquatic plant that occurs exclusively in a wet depression on top of Arkansas' Magazine Mountain, the Micosukee gooseberry, a shrub found only in the vicinity of Lake Micosukee in Florida and again 200 miles away along Stevens Creek in South Carolina, and the rockhouse goldenrod, a very rare species confined to areas beneath overhanging sandstone cliffs in the Red River Gorge of Kentucky.

One new project we are about to embark on is a Red Data Book for North American Lichens.

The work of the IUCN is crucial to the continued existence of the natural resources of the world. I know that our work with North American plants will be an important contribution to the total picture.

The Occurrence of Prairie and Forest Fires in Illinois and Other Midwestern States, 1679 to 1854

William E. McClain and Sherrie L. Elzinga

Illinois Department of Conservation
Springfield, Illinois 62706

ABSTRACT

Ring fires were used by the Native Americans of Illinois and other midwestern states in the annual hunts for bison and deer. Ring or partial ring fires were used during Indian Summer, a period of mild, dry weather in October and November that is known as a singularity in the meteorological literature. The Native American tribes had a very well developed system for hunting that included a "fire chief" that directed the hunt. Unlike the Native Americans of the western states who used fire for hunting in the spring and fall, the fire hunting in Illinois and other tall grass prairie areas was done almost exclusively in the fall. Fire was an asset to Native Americans, but it was a threat to the lifestyle of European pioneers. They began to use late spring burns, plowing, grazing, and overseeding with Kentucky bluegrass to reduce the danger of fire.

INTRODUCTION

Prior to the arrival of European man, what is now the State of Illinois was a mixture of forest, savanna, and prairie. Prairie, a plant community composed of grasses, wildflowers, and a few shrub species, occupied about 22 million acres of land, mostly in the northern two thirds of the state where a flat to gently rolling topography prevails. At the time of European Settlement, all but eight of the 102 counties of Illinois had large areas of prairie within their boundaries (McManis 1964). Forest occupied about 14 million acres in groves, narrow belts along streams, or in areas of rugged topography such as the Shawnee Hills Region in the Southern part of the state. Illinois was the first state that the pioneers encountered with large expanses of prairie, causing Illinois to be known as the "Prairie State", a nickname which persists to this day.

Floristically, Illinois is a part of the oak-hickory forest region (Braun 1950), a mosaic of prairie, savanna, and forest (Küchler 1964), or the eastern part of the prairie peninsula (Transeau 1935). The eastern edge of this prairie ecosystem was characterized by the tall prairie grasses, big bluestem (*Andropogon gerardii* and Indian grass (*Sorghastrum nutans*) (Risser *et al.* 1981). At the time of settlement by the Europeans, the largest expanses of prairie were located in central Illinois in what is known today as the Grand Prairie Division (Schwegman 1973).

Based upon pollen studies in sediments of wetlands, it appears that prairie vegetation entered Illinois from the west during a prolonged hot, dry era known as the hypsithermal period approximately 8300 years ago (King 1981, Axelrod 1985). Since this time, the climate has fluctuated between one capable of supporting prairie or forest, but periodic droughts probably continued to be a feature of the climate. Tree ring research indicates that Illinois has experienced several severe droughts during the last 300 years, including the decades of the 1930's, 1890's, 1820's, and 1700's (Blasing and Duvick 1984). The tendency for drought occurs about every 20 years and may be related to the Hale solar cycle of about 22 years and the lunar-tidal cycle of 18.6 years (Blasing and Duvick 1984).

NATIVE AMERICANS

Prior to the arrival of the Europeans, Illinois was inhabited by Native American tribes, including the Peoria's, Cahokia's, Kaskaskia's, Tamaroa's, Miami's, Kickapoo's, Sauk, Fox, Winnebago, and Potawatomie (Temple 1958). Although these people raised maize and other cultivated crops (Trigger 1978), their

livelihood, particularity during the winter, was also dependent upon hunting. In the fall, these tribes prepared for the annual hunt for bison. Unlike Native Americans of the western plains, these people did not have horses, a deficiency that was compensated for by the use of fire (Schoolcraft 1953).

One of the first descriptions of the use of fire in hunting by Native Americans in Illinois was written in 1679 by Louis Hennepin, a Jesuit priest. He described a bison hunt by the Miami Indians near the present site of Kankakee:

> "When they see a herd [of bison], they gather in great numbers, and set fire to the grass every where around these animals, except some passage that they leave on purpose, and where they take post with their bows and arrows. The buffalo, seeking to escape the fire, are thus compelled to pass near these Indians" (Hennepin 1880).

This method of hunting bison is also described by Charlevoix (1761) in the year 1720 on the upper Mississippi:

> "The kind of hunting most in vogue, is that of the buffalo, which is performed in this manner: The huntsmen draw up in four lines, forming a very large square, and begin by setting the grass on fire."

These narratives are some of the first articles to describe the use of a ring or partial ring of fire for bison by Native Americans in Illinois. The use of ring fires by Native Americans in hunting bison apparently was widely practiced and was also used for deer (Table 1).

The bison apparently were very afraid of fire, a characteristic that caused them to retreat from the flames. When bison were pressed together by the advancing fire, the hunters advanced upon them with their arrows. Father Rale, about 1718, said that there is no year during which the Illinois Indians fail to kill more than 2,000 buffalo (Roe 1970). Perrot (In Blair 1969) states that the Illinois Indians and their neighbors have no lack of wood for drying the meat that was cut into thin strips. Deliette (1934) also describes the drying of buffalo meat following a summer hunt in which 1,200 bison were killed by the Illinois. The success of the Illinois appears to be substantiated in the writing of LaSalle as he travelled through the upper Illinois River in the 1670's:

> "On the right hand and on the left stretched the boundless prairie, dotted with leafless groves and bordered by gray wintry forests, scorched by the fires kindled in the dried grass by Indian hunters, and strewn with the carcasses and the bleached skulls of innumerable buffalo. The plains were scored with their pathways, and the muddy edges of the river were full of their hoofprints. ... At night the horizon glowed with distant fires, and by day the savage hunters cound be descried at times rooaming on the verge of the prairie" (LaSalle In Parkman 1891).

The use of fire in hunting by the Native Americans may seem at first thought to have been an unorganized, spontaneous, and haphazard procedure. Evidence indicates, however, that the organization of the fire hunt in Illinois was very carefully planned and organized. Perrot (In Blair 1969) states that a "fire chief" chosen by the tribe at a council meeting directed the fire hunt. He organized three separate crews, and at midnight on the designated day, directed the crews out onto the prairie to surround the bison. As dawn approached, the circle would be completed and once the morning sun had dried the dew from the grass, it was set on fire and the hunt began. Severe penalities were also imposed upon anyone that might scare the bison away, including the destruction of personal belongings, weapons, and their living quarters (Perrot, In Blair 1969; Charlevoix 1761).

The Native American hunters also utilized weather patterns and included them in their fire hunting plans. James Smith (In Washburn 1977), an individual who was captured, adopted, and lived with Native Americans from 1755 until 1759, described a fire hunt for deer on a prairie between the

Sandusky and Scioto Rivers in Ohio:

> "When we came to this place we met with some Ottawa hunters, and agreed with them to take what they call a ring hunt in partnership. We waited until we expected rain was nearly falling to extinguish the fire, and then we kindled a large circle in the prairie. ...The rain did not come on that night to put out the outside circle of the fire, and as the wind arose, it extended through the whole prairie which was about fifty miles in length and in some places near twenty in breadth. This put an end to our ring hunting this season, and was in other respects an injury to the hunting business."

The use of fire in hunting by the Native Americans apparently continued after the arrival of the Europeans in the early part of the nineteenth century. Numerous letters, diaries, and books written by the pioneers describe the prairies and the spectacular fires that occurred on them. Almost without exception in Illinois, these fires occurred in the fall of the year during a period of warm, mild weather that we know today as "Indian summer".

INDIAN SUMMER

Sauer (1950), in writing about grasslands throughout the world, stated that there were grasslands in areas of high rainfall and low rainfall. Locations that have a dominance of grassland at one site elsewhere have a dominance of forest under nearly identical climatic and edaphic conditions. Despite their differences, grasslands throughout the world have two characteristics in common which are: (1) a nearly level to gently rolling topography, and (2) a season of the year during which the vegetation becomes dry (Sauer 1950). These are the conditions ideally suited for the kindling and movement of fire.

In Illinois there is a season known as "Indian Summer" which occurs in late October and early November following the first killing frost (Wells 1819). At this time a mass of Pacific air dominates the weather pattern, producing days with clear skies, mild temperatures, low humidities, and westerly winds (Bryson and Lahey 1958; Huschke 1959). This season usually occurs every year and is known in the meteorological literature as a singularity (Wahl 1952, 1954). Today, most individuals are familiar with the name "Indian Summer" for this pleasant autumn time which is characterized by clear skies and mild temperatures. However, many circumstances associated with this season are much different today compared to historic times when the vast prairies of Illinois were the realms of the bison and the hunting grounds of Native Americans. Some early descriptions of the vegetation and weather during this season indicate the combustible conditions that existed:

> "It is by no means necesary that they (prairies) should be always dry; on the contrary, if they are sufficiently level to prevent the rains from running off immediataely, the grass will grow thicker and higher--but they must be sufficiently dry to burn, at least once in two or three years, during the long, dry season called Indian summer. .....commencing usually in October, and continuing a month and a half or two months, during which the vegetation is killed by the frosts, and dried by the sun" (Wells 1819).

> "Frosts have already put a stop to vegetation. The leaves have fallen, annual plants have become dry, and the fields, the swamps, the forests and the prairies are set on fire by Indians and hunters. .....We have had three weeks of Indian summer, with all that peculiar redness of the sky, mentioned above, in great perfection. The prevailing winds were west and north of west, with a dry atmosphere. The country was on fire in various places for forty miles around us" (Foot 1836).

The burning of thousands of acres of prairie had profound effects upon the atmosphere for hundreds of miles. Some of the descriptions of the smoky atmosphere indicate the conditions that existed for two to four weeks in the areas of the tall grass

prairie:

> "About the middle of October or beginning of November, the Indian Summer commences, and continues from fifteen to twenty days. During this time, the weather is dull and cheerless, the atmosphere is smoky, and the sun and moon are sometimes almost totally obscured. It is generally supposed that this is caused by the burning of the withered grass and herbs on the extensive prairies of the north and west" (Mitchell 1837).

> "So long back as we have any knowledge of the country, it has been the custom of the Indians to set fire to the prairie grass in autumn, after frost set in, the fire spreading with wonderful rapidity, covering vast districts of country, and filling the atmosphere for weeks with smoke" (Caird 1859).

> "The thick and tall grass that grows in the prairies that abound through all the country, is fired; most frequently at that season of the year, called Indian Summer. The moon rises with a broad disk, and of a bloody hue, upon the smoky atmosphere. Thousands of acres of grass are burning in all directions" (Flint 1826).

> "The sky in the night time is of a fiery red, and the smoke in the day prevents the sun from being seen until 10 o'clock in the forenoon. This smoky season is what is called here Indian Summer" (Newhall 1821).

> "The season, called the Indian Summer, which commences in October, by a dark blue hazy atmosphere, is caused by millions of acres, for thousands of miles around, being in a wide-spreading, flaming, blazing, smoking fire, rising up through wood and prairie, hill and dale, to the tops of low shrubs and high trees" (Faux 1817).

Dr. Lyman Foot, a physician located at Fort Winnebago in what is now Columbia County, Wisconsin, stated: "If you ask a 'Native American' when he is going to his hunting ground, he will tell you , when our fall summer comes, or when the Great spirit sends us our fall summer, meaning that time in October and November when a period of warm, mild weather dominates the weather pattern" (Foot 1836).

The pioneers apparently were the ones that gave the mild season that occurred toward the end of October the name of Indian Summer. The Native Americans apparently continued their ancient practice of fire hunting for about 150 years following the arrival of the Europeans. These pioneers, upon seeing and experiencing these tremendous prairie fires, gave the name Indian Summer to this time of the year.

ARRIVAL OF EUROPEAN MAN

The arrival of the pioneers heralded the beginning of a prolific number of books, journals, letters, and manuscripts which described the new country. Although many of these descriptions are very general and are largely directed at enticing others to the new country, some documents describe actual fires and many of these are fires within Illinois. Descriptions of 54 prairie or woodland fires were discovered, and some give very detailed accounts of the fires, including wind direction and an estimate of the size of the area burned (Table 2).

The prairie fires were one of the most dreaded fears of the pioneers throughout the prairie regions of Illinois. The uncontrolled grassland fire destroyed crops, fences, buildings, livestock, and sometimes took the lives of the settlers (Reynolds 1887, Gerhard 1837). Because of this danger, farms and homesteads were established at the woodland edge instead of the dense grass of the open prairies. Due to the high danger of fire, pioneers "slept with one eye open" from the time of the first killing frosts in the fall until snow covered the ground (Baldwin 1877).

The presence of buildings, crops, livestock, and a growing number of settlers made the occurrence of widespread prairie fires more undesirable with each passing year. Eliminating the prairie fires became a primary goal of the pioneers, and that meant the elimination of the prairies and their tall grasses which became tinder dry in the fall. By burning the prairies late in the spring, some pioneers learned that the danger of fire could be reduced the following fall (Baldwin 1877). However,this practice did considerable damage to nesting prairie chickens (Kennicott 1855, Schorger 1944), but this was sometimes the objective of the burn because the birds were eating too much of the farmer's grain (Schorger 1944). Others found that cool season grasses such as bluegrass could be sown on a prairie following a fire. This grass would germinate, easily establish itself, and further reduce fire danger because it would never burn as readily or produce as much biomass as the native grasses (Baldwin 1877, Short 1845, Mitchell 1837).

Prairies were also burned in the spring to facilitate plowing. Mary Sackett, a young girl in Winnebago County, wrote the following description:

> "In the forenoon Papa measured off some land for Mr. Cole to break, and set fire to the grass, as it is better to be burned over" (Sackett 1842).

Plowing had long been a method of reducing fire danger around homes, crops, and other property since the arrival of the Europeans (Baldwin 1877, Gerhard 1857). Despite the efforts to reduce fires, they continued to be an annoyance and a menace to crops, livestock, and property. Some form of legal protection from these prairie fires was demanded, and anyone caught setting a fire certainly aroused the rath of the public, particularly if the fire caused damage to personal property.

In 1794, Louis Giroux was indicted in St. Clair County Court for setting fire to the commons at Prairie du Dupont (currently known as Dupo), resulting in the loss of fence rails in Cahokia and Prairie du Pont (St. Clair County Circuit Court Case 355, Illinois State Archives). In 1807, while Illinois was still a territory, a petition was prepared by the citizens of Gallatin County, Illinois complaining about the lack of legal protection against prairie fires and the damage they were doing to their buildings and livestock (Anonymous 1815). Due to the increased demand for legal protection, the territorial legislature passed a law in 1815, making it a misdemeanor to burn prairies except those on an individuals own property. Individuals found guilty of this misdemeanor were subject of a fine of not less than \$5 or more than 100 dollars while a servant had to pay the fine and be whipped not more than 39 stipes (Philbrick 1930). This act also defined the season during which prairies could be legally burned, and may have contributed to the emphasis placed on spring burning by the European pioneers:

> "Nothing in this act shall be so construed as to prevent any person or persons from setting on fire prairies or cleared land (on their personal property) between the first of December and the 10th day of March" (Philbrick 1930).

The law in effect in 1845 made the negligent, careless, intentional, or wilful burning of prairies or woods illegal except for the necessary preservation of personal property after giving two days notice to neighbors. Such firing of the woods or prairies could be done from the first day of March until the last day of November (Brayman 1845). However, this act was rarely enforced, and few convictions were ever made. One notable exception is Peter Johnson of Kane County, whose son, John Johnson, set fire to the prairie on Peter Johnson's property on November 15, 1845 (Johnson versus Barber 1846, Kane County Circuit Court, April Term, Illinois State Archives). The fire passed onto the land of his neighbor, Newman Barber, burning up his crops (500 bushels of wheat, 500 bushels of oats, and 15 tons of hay), and 6,500 rails for fences, having a presumed value of \$1,480. Johnson was indicted and the case went to the Illinois Supreme Court which affirmed the ruling of the circuit court and awarded the plaintiff, Newman Barber, \$489 for his losses due to the fire (Johnson versus Barber 1846, 1886). For some unknown reason (perhaps to pay the judgement), 385 acres of land belonging to Peter Johnson was seized and sold at public auction by the Kane County Sheriff, B. C. Yates (Johnson versus Barber 1846). Ironically, the land was purchased by none other than the plantiff, Newman Barber

(Johnson versus Barber 1846).

DISCUSSION

A total of 12 sources of fires attributed to Native Americans were located in the literature (Table 1). Information on an additional 54 fires was located in the literature during the period of European settlement from 1818 to 1860 (Table 2). The source of the ignition for most of these fires in Table 2 is not known, but it is assumed that most were deliberately set or were started accidentally by Europeans or the Native Americans that remained in Illinois until the 1830's. However, three fires in Livingston County almost certainly were caused by lightning (Woods 1861). The paucity of lightning caused fires is at least partially explained by the difficulty in observing lightning strikes on the prairies, and the sparse populations of the time, especially the Grand Prairie region of Illinois which remained unsettled until the advent of the railroads in the 1860's.

Moore (1972) found that the Native Americans on the prairies of the great plains utilized fire during the spring and the fall months in the Central and Northeast regions of his study area. The data that were collected during the present study indicate that the Native American tribes of Illinois used ring fires in their annual bison or deer hunts which were performed by these tribes to ensure a food supply for the winter months (Table 1). The tall grass prairies of Illinois and adjacent states were burned in the fall during that time of the year that we call "Indian Summer".

These fires were widespread and burned over considerable acreages. During dry years, these fires did extensive damage to trees, and appear to have entirely eliminated areas of forest in some localities (Reynolds 1887, Caton 1869). The sound of falling trees during a woodland fire in the vicinity of Princeton, Indiana in 1819 was described by Faux (1823) as like "the discharge of an ordance". During wet falls, the fires were not nearly as much of a threat (Woods 1822, Blane 1825).

The fires had long been an asset used in deer and bison hunting by the Native Americans, but widespread fires were a liability to the Europeans and a source of much apprehension and loss. They began a program of fire protection and eradication by using a combination of plowing, grazing, spring burning, or the overseeding of bluegrass or other cool season grass on the prairie sod following a burn in efforts to eliminate the dense prairie grasses (Baldwin 1877, Short 1845, Beckwith 1880). Eliminating the fires was a primary objective and that meant the elimination of the prairie. During early pioneer times the desire to eliminate fires appears to be as much a reason for destroying prairie as was the desire for farmland. The sentiment of most of the pioneers was expressed by George Ogden when he stated that "these awful conflagrations take place in autumn" (Ogden 1966).

One of the tools used to prevent large dangerous fires, spring burning, appears to be an introduction of European man. Not one record or reference to spring burning was found during the early settlement and exploration of the Illinois Territory (Table 1), but observations of spring fires were located in literature pertaining to the settlement of Illinois from 1816 to 1866 (Table 2). This practice apparently was used extensively during the settlement of Illinois (Baldwin 1877, Short 1845, Gerhard 1857). In Kentucky, following the removal of the Native Americans, F. A. Michaux reported that the inhabitants set fire to the grass of the barrens during March or April (Thwaites 1904). Many of the pioneers that moved to Illinois were from Kentucky, and they may have continued this practice of spring burning on the prairies of Illinois.

Following the cessation of the prairie fires, forest began to invade the prairies at a rapid rate. As early as 1819, Bourne (1820) stated:

> "When the white people settle on the barrens or near them, the Indians recede, fires are seldom seen, and a young growth of trees, healthy and vigorous soon springs up, far superior to the stinted growth which the frequent fires have scorched."

Some of these trees probably were "grubs" in the prairie that managed to survive the repeated fires as sprouts, but never could reach tree size. The cessation of prairie fires approximately 150 years ago appears to coincide with the beginning of the

successional changes that are continuing in midwestern oak-hickory forests (Ebinger and McClain 1991, Cottam 1949, Kline and Cottam 1979).

Transeau (1935) stated that the environmental extremes such as a very severe drought were the factors that had the greatest influence upon modifying the plant communities of an area. During years of severe drought, the prairie fires were much more widespread than those during wetter falls (Woods 1822). It thus seems likely that severe droughts produced conditions for severe fires and these two forces, acting together greatly modified and shaped the plant communities of Illinois.

As natural area managers, much of the prescribed burning that we conduct is done in the spring instead of during Indian summer as in historic times. Could it be, due to differences in weather, that we are not achieving the best results from prescribed burning because we are not utilizing Indian summer, the season that was historically the season of fire on the prairies and in the woods of Illinois?

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Table 1. Ring fires and fire hunting by Native Americans in Illinois and other Midwestern states, 1673-1831.

DATE	LOCATION	TRIBE	PURPOSE	SIZE (ha)	REFERENCE
November 9, 1836	Ft. Winnebago,	Unknown	-	1,000's	Foot 1836
Fall 1679	Kankakee, IL	Miami	Bison hunting	-	Hennepin 1679
Fall 1831	Winnebago Co., IL	Potawatomie	Deer "	-	Letts In Angle
Fall 1819	General	Unknown	-	-	Ernst 1903
Fall 1820	General	Unknown	-	-	Williams 1953
Fall 1812	General	Unknown	Deer hunting	-	Stoddard 1812
Fall 1766	Illinois	Unknown	Bison "	-	Carver 1792
Fall 1720	Upper Mississippi	Illinois	Bison "	-	Charlevoix 1761
Fall 1683	Illinois	Miami	Bison "	-	Shea
Fall 1720	Illinois	Illinois	Bison "	-	Perrot,In Blair 1967
October 1763	Ohio	Ottawa	Deer "	1,000's	Smith, In Washburn 1977
1820's	Mississippi Valley	Unknown	Deer "	-	Reynolds 1887
1820's	Central Illinois	Unknown	Bison "	-	Flint 1826
Fall 1673	Upper IL River	Illinois	Bison "	-	LaSalle, In Parkman 1891

Table 2. Prairie and woodland fires in Illinois and other Midwestern states, 1816-1866.

DATE	LOCATION	WIND	FIRES	REFERENCE	WEATHER
Fall 1816	Bond Co., IL	-	1	Perrin 1882	-
Fall 1816	Bond Co., IL	-	1	Perrin 1882	-
Fall 1825	Bond Co., IL	-	1	Oliver 1843	-
Nov. 3, 1821	Bond Co., IL	-	2	Newhall 1836	-
Oct. 15, 1835	Bureau Co., IL	W	6	Brunson 1835	Dry
Fall 1822	Clinton Co., IL	-	2	Blane 1824	Dry
Oct. 21, 1843	Coles Co., IL	-	1	Hendrick and Hendrick 1981	-
Oct. 7, 1850	Cook Co., IL	-	1	Cunyhame	-
Oct. 30, 1818	Edwards Co. IL	S	6	Fordham 1906	-
Oct. 6, 1819	Edwards Co., IL	W	2	Faux 1823	-
Fall 1819	Edwards Co., IL	-	1	Flower 1822	Dry
Fall 1822	Gallatin Co., IL	-	1	Tillson 1919	-
Oct. 30, 1819	Gallatin Co., IL	-	3	Wood 1822	Dry
Fall 1860	Livingston Co., IL	W	3	Woods 1867	-
Fall 1836	Logan Co., IL	-	1	Stringer 1911	-
Fall 1836	Logan Co., IL	-	1	Stringer 1911	-
Fall 1821	Madison Co. IL	-	1	Ogden 1823	-
Fall	Madison Co., IL	-	1	Rambler in the	-
Fall 1854	Marshall Co., IL	W?	1	Elsworth 1880	Dry
	Mason Co., IL	S	1	Onstot 1902	-
Oct. 21, 1853	Mercer Co., IL	-	3	Marsh 1853	-
Fall 1866	Pochontas Co, IA	S	1	Flickenger 1904	Dry
Fall 1833	Putnam Co., IL	-	2	Hoffman 1835	-
Fall 1819	Sangamon Co.,IL	W	1	Selby 1912	Dry
Fall 1829	Schyler Co., IL	-	1	Larkin 1830	-
Fall 1825	St. Louis, MO	-	1	Flint 1826	-
Nov. 1836	Stark Co.,IL	S	-	Matson 1872	-
	Stephenson Co., IL	-	1	Bateman and Selby 1914	-
Oct. 1836	Tazewell Co., IL	W?	3	Farnham 1846	-
Fall 1849	Wisconsin	-	1	Gerhard 1857	-
Fall 1832	Lee Co., IL	-	1	Kennedy 1893	-
Fall 1852	Woodford Co., IL	-	1	Wilson 1857	-
Fall 1830's	St. Louis, MO	-	1	Catlin (No date)	-
Aug. 27, 1833	Dekalb Co., IL	-	1	Benton 1957	-
Feb. 12, 1817	Edwards Co., IL	-	1	Monaghan 1946	-
Dec. 16, 1818	Edwards Co.,IL	-	1	Monaghan 1946	-

Overstory Vegetation along an Upland to Swamp Gradient in Southern Illinois

Philip A. Robertson

Department of Plant Biology
Southern Illinois University
Carbondale, IL 62901

INTRODUCTION

Bottomland forests comprise one-fifth of all commercial forest land in Illinois. From data presented by Telford (1926) and the U.S.D.A. (1978), I estimate that the bottomland forests of Illinois have been reduced in area by 98% as a result of clearing and draining. In Missouri, 96% of the original 1,000,000 ha of bottomland forest have been lost (Korte and Fredrickson 1977). In southern Illinois, only a few relatively undisturbed bottomland hardwood forests remain. These undisturbed forests provide an excellent opportunity to study the compositional and structural characteristics of this vegetation type near the northern limits of the Southern Floodplain Forest. It is in these relatively undisturbed stands that relationships between species and soil-site variables most closely represent the potential vegetation of this forest type. Also, these stands offer an opportunity to study tree growth in relation to flooding and climate.

STUDY AREAS

Little Black Slough and Goose Pond (MacKenzie 1980) are included in a 1,102 ha tract along the Cache River floodplain and backwater lowlands in Johnson County, Illinois. On the northern edge of the tract is the 35 ha Goose Pond study area which contains a pure stand of virgin *Taxodium distichum* along with the adjacent floodplain and uplands. Along the southern edge of Little Black Slough is the 100 ha Boulder Slope Woods and its associated floodplain and swamp. Boulder Slope Woods is the least disturbed upland portion of the Little Black Slough tract and Goose Pond contains the least disturbed swamp stand. The floodplains of both the Boulder Slope area and Goose Pond have experienced some selective removal of canopy trees. Little Black Slough and Goose Pond are located in the Shawnee Hills Section of the Interior Low Plateaus Province in southern Illinois. However, the uplands of this area contact the Coastal Plain Province along the floodplain.

The Horseshoe Lake study site is located about 19 km northwest of the confluence of the Ohio and Mississippi Rivers. The old-growth forest occupies about 35 ha on a floodplain island about 5 km east of the Mississippi River channel (Robertson *et al.* 1978). There is little evidence of logging in the Horseshoe Lake stand but some large trees are falling and creating gaps in the canopy. Horseshoe Lake is located entirely in the Coastal Plain Province (Schwegman 1973).

Pine Hills is located on a peninsula adjacent to an abandoned channel of the Big Muddy River on the Mississippi River alluvial plain in Union, County Illinois about 48 km north of Horseshoe Lake. Pine Hills is a second growth forest following extensive cutting in 1944, although some large old trees remain in the canopy. This site was used only for tree growth measurements.

The Stanley Creek area of Mingo Wildlife Refuge is located 65 km west of the Mississippi River in Stoddard and Wayne counties, Missouri (Elliott 1981). Much of Mingo was logged and drained in the late 1800's (Korte and Fredrickson 1977, Fredrickson 1979, Elliott 1981). Clearing was incomplete and some old-growth forest remained. A 32 ha tract near Stanley Creek was selected for study because of the lack of man-caused disturbance.

Soils of the study areas range from very rocky on the slopes to very clayey in the lowlands. For a more detailed description of the soils of the study areas, see Fehrenbacher & Walker (1964), Parks *et al.* (1968), Fredrickson (1979), and Gurley (1979). Maximum relief of the study areas is about 60 m. Slope angles are nearly level on the alluvial flats to

70% on the uplands. At Horseshoe Lake and Pine Hills, the gently undulating relief varies less than 3 m. The region has mild winters, warm summers and abundant rainfall. Average annual precipitation of the study sites ranges from 1050-1150 mm (Page 1949, Fehrenbacher and Walker 1965, Fredrickson 1979).

METHODS

A total of 181, 98, 129 and 72 plots were sampled in Little Black Slough, Goose Pond, the old-growth stand on Horseshoe Lake Island, and Mingo Wildlife Refuge, respectively. In all four study areas, transects were established about 100-150 m apart and perpendicular to the predominant topographic gradient (high to low elevation). Along each transect, 0.04 ha rectangular plots (66.6 x 6.0 m) were placed 15-30 m apart. Distance between plots depended on topography. When topographic change was rapid (*i.e.* steep slopes), plots were close together and when topography was level, plots were apart. Within each plot, all trees (≥6.6 cm) were recorded by diameter breast high (dbh) or diameter above the buttress (dab). Nomenclature follows Mohlenbrock (1975). Depth to and texture of the least and most permeable soil horizons and maximum depth of flooding were measured in each plot. Flooding was either measured directly (Horseshoe Lake and Goose Pond) or determined from the high water mark on the trees. Soils were sampled using a tube sampler and texture was estimated in the field. In addition, soil samples from all plots in Goose Pond, Horseshoe Lake, and from about 10% of the Little Black Slough plots were analyzed in the laboratory for texture (Bouyoucos 1951) to verify field estimates. The vegetation at the Pine Hills site was sampled as above to obtain structural and compositional information for comparative purposes (Robertson 1992). These data were not analyzed with the vegetation data from the other four sites.

Data from the four sites were combined in separate basal area and soil-site matrices for analysis. The 15 rarest species were deleted to reduce the influence of zero values in the analysis. Vegetation data were ordinated by Detrended Correspondence Analysis (DECORANA; Hill 1979a, Hill & Gauch 1980). The ordination sequence from DECORANA was used to fit Gaussian response curves for the major species (Gauch and Chase 1974, Westman 1980). The DECORANA ordination was interpreted by multiple regression. Environmental variables were used as predictors and the ordination scores for the plots were used as the dependent variable. TWINSPAN (Two-way Indicator Species Analysis, Hill 1979b) was used to identify community types in the study areas.

Data on historical tree growth were obtained by extracting increment cores from individuals of the dominant oak species at the Pine Hills, Horseshoe Lake and Little Black Slough sites. Four hundred and seventeen cores from 8 oak species were analyzed. An attempt was made to include species common to all sites; however, certain species were found on only one or two sites. Increment cores were taken from opposite sides of the tree, checked for integrity and mounted in the field in grooved wooden trays. In the laboratory, cores were shaved with a sharp razor blade and sanded with white fine grit sandpaper to emphasize ring boundaries. Before measuring, all cores were dated and decade intervals marked on the core (Stokes and Smiley 1968). Ring widths were measured to the nearest 0.01 mm using a Henson University Model incremental measuring machine. See Robertson (1992) for more detail on dendrochronology methods.

The biological variance in the tree-ring measurements was removed by calculating standardized ring-width indices using program ARSTAN from the Laboratory of Tree-Ring Research (Holmes *et al.* 1986). Detrending of each ring-with series is essential to remove variance due to differential mean growth among trees, biological growth trend and other low-frequency variance before averaging each ring-width series into the chronology. Average monthly temperature and precipitation from Cairo, Illinois from October preceding the growth year through September of the current year were the environmental variables used in these analyses. Average monthly river stage values for the Big Muddy River (Murphysboro IL., about 28 km NE of Pine Hills) were correlated with growth indices for the Pine Hills site while discharge values from the Mississippi (Thebes, IL., about 16 km NW of Horseshoe Lake) and Cache (Forman, IL., about 5 km SE of Little Black Slough) rivers were used for the Horseshoe Lake and Little Black

Slough study areas, respectively.

RESULTS

Structural characteristics for the three study areas are shown in Table 1 to indicate variation among the areas. Tree density was lowest at Horseshoe Lake and highest at Mingo Wildlife Refuge. Basal area was highest at Goose Pond and species richness highest at Horseshoe Lake. The Pine Hills study site supported a tree density of 568.8 stems/ha and a tree basal area of 24.2 m^2/ha.

Ordination of the overstory data sets resulted in a uniform scatter of samples from upland and swamp sites on opposite ends of the first axis and floodplain sites in the middle. Gaussian curves were fit for each species on the basis of the DECORANA ordination scores to form a coenocline. The coenocline accounted for 54% of the variance with curves for individual species accounting for as much as 95% of the variance (Fig. 1). When the ordinations are related to soil-site variables, it is evident that species are distributed along a complex flooding-soil textural gradient. Multiple regression analysis of the overstory ordination indicated that 63% of the variance (R^2) in the ordination sequence could be accounted for by depth of flooding and percent clay in the most and least permeable horizons.

TWINSPAN classification of the overstory samples from all four study areas revealed eight groups which can be ordered along a topographic-moisture gradient (Table 2). Dominant species in the upper slope community are oaks and hickories while mesophytic species such as *Acer saccharum* and *Quercus rubra* dominate lower slopes and well drained ridges in the floodplain. These areas are characterized by minimal flooding and low clay and relatively high sand content. Two lower slope-shallow floodplain communities had different dominant species; one area dominated by *Quercus phellos* and *Q. palustris* and the other dominated by *Liquidambar styraciflua* and *Ulmus americana*. Flooding depth, clay content and silt content were similar for these two areas; however, sand content was lower in the shallow floodplain than in the lower slope-floodplain transition. Two floodplain types were identified, one dominated by *Quercus lyrata* and the other by *Acer rubrum*. The soil-site environment of the two floodplain types differed primarily in that clay is higher in the *Acer rubrum* type. The two swamp groups differ primarily in the shift in dominance between *Nyssa aquatica* and *Taxodium distichum* and in depth to the least permeable horizon and maximum depth of flooding (Table 2).

In the tree growth analysis, the most frequently occurring (14 of 16 species-site groups) significant correlation was the negative relationship between mean June temperature and the ring-width indices. The second most frequently occurring (11 of 16 species-site groups) relationship was the significant positive correlation with June precipitation. Generally high summer temperature were negatively correlated and growing season precipitation totals were positively correlated with growth indices. In several species-site groups, monthly precipitation and temperature of the winter months preceding the growing season, particularly December moisture, showed a significant positive correlation with tree growth (Table 3).

Correlations between river discharge and growth indices were positive for all species at the Pine Hills and Little Black Sough sites while only one species at Horseshoe Lake, *Q. alba*, had a significant correlation to June discharge of the Mississippi River. At Pine Hills and Little Black Slough, summer discharge (June-August) and spring discharge (March-May) were significant for most species-site groups. Discharge during the winter (November-February) preceding the growing season was significant in 4 of the 16 groups. Significant correlations for all species-site groups are not exceptionally strong and are often strengthened by a few extreme values in discharge rates. Response function analysis (Fritts 1976) indicated that the proportion of variance in ring-width indices accounted for by river discharge was low at all sites.

DISCUSSION

Average density of woody stems, basal area and species richness for the three study areas are characteristic for relatively undisturbed forests of this region. Basal area of the upland sites are within the range of values reported for similar sites in the Western Mesophytic and Oak-Hickory forest regions (Braun 1950, Rochow 1972, Fralish 1976, Adams and Anderson 1980). Basal area of lowland sites is

similar to those reported for the Wabash and Tippecanoe rivers in Indiana (Lindsey *et al.* 1961, Schmelz and Lindsey 1965), a floodplain site in northern Florida (Brown 1981), and higher than the 28 and 24 m^2/ha of the floodplain hardwood and flatland hardwood types described in the Big Thicket of Texas (Marks and Harcombe 1981). Adams and Anderson (1980) reported the basal area of a lowland forest in central Illinois to be 45.4 m^2/ha which is slightly higher than in the floodplain types defined in this study or than the 41.4 m^2/ha encountered in the Horseshoe Lake floodplain stand (Robertson *et al.* 1978). The higher basal area in the Horseshoe Lake old-growth woods relative to the three study areas is probably due, in part, to the less disturbed condition of that stand. High basal area in the swamp is due to the large *Taxodium distichum* in Goose Pond and the high density of *Nyssa aquatica* in Little Black Slough. The swamp basal area is similar to the 62.8-90.1 m^2/ha reported for Heron Pond which is adjacent to Little Black Slough and Goose Pond on the Cache River (Anderson and White 1970), but lower than the exceptionally high 138 m^2/ha reported for one stand in the Big Thicket of southern east Texas (Marks and Harcombe 1981). Swamp forest of this region support basal areas similar to those elsewhere in the Southern Floodplain Region (*cf.* Schlesinger 1978). Lowland forests throughout this region are capable of supporting a relatively high basal area which may be maintained by nutrient subsidies from periodic flooding (Mitsch 1978).

Indirect gradient analysis of the overstory using DECORANA provided a plot sequence which was related to the environmental variables as indicated by the regression analyses. This indirect, integrative approach is useful in interpreting vegetation and soil-site relationships along complex gradients and has been used successfully by others (Robertson *et al.* 1978, Marks and Harcombe 1981, Muller 1982). The coenocline portrayed in this paper should be interpreted with some reservation as not all species occurred in all study areas.

Environmental relationships of overstory species are similar to patterns reported in other studies (Wells 1942, Bell 1974, MacKenzie 1980, Robertson *et al.* 1978, Fredrickson 1979). The studies by Hosner (1957), Hosner and Boyce (1962), Broadfoot (1969), Broadfoot and Williston (1973), Keely (1979), and Bedinger (1979) indicated the importance of flooding as it affects the growth and survival of many lowland species. Depth of flooding is the most important variable related to ordination sequence and vegetation plot classification. Generally the distributions of the more common species in relation to flooding in our study areas coincide with the scheme presented by McNight *et al.* (1981) with some exceptions. *Populus heterophylla* and *Quercus lyrata* appeared to be more tolerant of flooding in our area than indicated by McNight *et al.* (1981). However, flooding does not account for all the vegetation variation supporting the idea that the existence of strong trends in the vegetation data need not imply a single controlling environmental influence (Hill and Gauch 1980). Along, the upland-swamp gradient in the region, several environmental variables are needed to explain the coenocline. Percent clay is important throughout the gradient and may affect species distribution by controlling water holding capacity and affecting aeration (Brady 1974). Wharton *et al.* (1982) point out that the 'moisture' gradient of the floodplain is misleading as it is not the availability of water but the lack of oxygen due to saturated soils that controls species distributions. McNight *et al.* (1981) indicate that is often difficult to determine species distributions based only on the flooding regime.

The eight community (dominance) types identified by TWINSPAN are, for the most part, related to soil-site conditions in the study areas and are similar in composition to community types throughout the Western Mesophytic Forest region and lowlands of the Gulf Coastal Plain (Braun 1950). The floristic composition on the slopes is comprised of species with broad geographical distributions while many floodplain species show southern affinities (Voigt and Mohlenbrock 1964). Species with southern affinities include *Liquidambar styraciflua, Quercus pagodaefolia, Q. michauxii Q. lyrata, Q. phellos, Q. shumardii, Taxodium distichum* and *Ulmus alata* (Voigt and Mohlenbrock 1964).

The upper slope and mesic communities are similar to those found in the Ozarks (Ashby and Kelting 1963) and Shawnee Hill (Fralish 1976) of southern Illinois as well as the Western Mesophytic Forest Region (Braun 1950). In southern Illinois, the *Quercus velutina-Q. alba* community is probably climax as indicated by the reproduction of both oak

species in the understory. Fralish (1976) reported the *Quercus rubra* communities of the Shawnee Hills merge into *Acer saccharum* communities on lower slopes. Such is not the case in the four study areas although large *Acer saccharum* occur in the Boulder Slope Woods of Little Black Slough and the well-drained ridges of Horseshoe Lake.

Most of the lowland types described in this study have been described in the Southern Floodplain Forest Region and correspond to the NWTC types (Larson *et al.* 1981). The *Liquidambar styraciflua, Ulmus americana, Acer rubrum* and *Quercus michauxii* type is similar to the 1) Sweetgum-bottomland Oak community described by Shelford (1954), the 2) Rufacer-Liquidambar-Quercus (Red Maple-Redgum-Oak) shallow transitional freshwater swamp described by Penfound (1952) and the 3) Floodplain Hardwood Forest in southeast Texas (Marks and Harcombe 1981). Characteristics species include: *Liquidambar styraciflua, Ulmus americana, Quercus phellos, Gleditsia triacanthos, Acer rubrum* and *Diospyros virginiana*. The transitional type defined in the Horseshoe Lake old-growth stand (Robertson *et al.* 1978) is a mixture of the mesic, mixed hardwood type described above and this shallow floodplain type. The environment of this type often includes saturated soil with periodic flooding (Penfound 1952).

The *Quercus phellos-Q. palustris* type corresponds somewhat to the Flatland Hardwood type described by Marks and Harcombe (1981) and may be successional to the *Liquidambar styraciflua* and *Ulmus americana* type. Both *Quercus phellos* and *Q. palustris* are light intolerant and considered to be subclimax (Fowells 1965). Also, site conditions may be important in differentiating these two floodplain types in this region. Weaver (in Eyre 1980) indicates that where drainage is improved, *Liquidambar styraciflua* persists in later successional stages and *Quercus palustris* disappears relatively early in the successional scheme. Where *Liquidambar styraciflua* is dominant in the study areas, sand content is relatively high, possibly facilitating drainage. Generally, species in this type are tolerant of periodic flooding and poor drainage (Putnam and Bull 1932). However, McNight *et al.* (1981) indicated both *Quercus phellos* and *Q. palustris* are less tolerant of flooding than *Liquidambar styraciflua*. This characteristic may relate to the difference in our two shallow floodplain types as the flooding depth was less in the *Quercus phellos-Q. palustris* type.

The *Quercus lyrata-Acer rubrum* deep floodplain type may be dominated by various species including *Quercus lyrata, Ulmus americana, Fraxinus pennsylvanica,* and *Acer rubrum* and is common in backwater lowlands. According to Wharton *et al.* (1982), this type occurs on the most poor drained flood plains where the hydroperiod extends well into the growing season and where soils are clayey (Putnam and Bull 1932). Vegetation, flooding regime and soils of the study area are similar to the NWTC Zone III classification for the southeastern United States (Larson *et al.* 1981). The *Acer rubrum-Nyssa aquatica* type described in this study is not well described elsewhere. Since the environment is not greatly different between these two types, the *Acer rubrum-Nyssa aquatica* type may be transitional between the deep floodplain and the swamp, or it may be successional to a *Quercus lyrata* dominated type. *Acer rubrum* may be associated with at least 51 forest types and is considered to be seral (Fowells 1965).

The swamp types defined in this study represent variants of the *Taxodium distichum-Nyssa aquatica* deep, fresh-water swamp described by Penfound (1952) which is typical for the southeastern Evergreen Forest Region (Braun 1950). The *Nyssa aquatica-Taxodium distichum* type described in this study may be a variant of the above resulting from the selective removal of *Taxodium distichum* (Putnam *et al.* 1960). Also, *Nyssa aquatica* may replace *Taxodium distichum* on some sites because of the erratic reproduction, slower growth and minimal sprouting ability of the latter species (Wharton *et al.* 1982). Because of the low species diversity and uniform conditions in which this type is found, it appears to be the least variable, throughout its range, of lowland forest types in the Eastern Deciduous Forest Region. Throughout the region as well as in this study area this forest type (NWTC Zone II) occurs in depressions where soil is often permanently saturated or submerged (Putnam and Bull 1932, Penfound 1952, Larson *et al.* 1981)

Results of the correlation analysis of the climatic variables on tree growth were consistent with other studies on eastern deciduous forest species and

indicate that lowland tree species respond similarly to their upland counterparts. Precipitation and temperature of spring and early summer months significantly influence growth of *Quercus macrocarpa* in Nebraska (Lawson *et al.* 1980), northern hardwoods in New Hampshire (Kim and Siccama 1987), *Quercus alba* in Indiana (Fritts 1982) and *Carya glabra* in Maryland (Hill 1982). Fritts (1962) found that high summer temperatures depress ring widths and that high early spring temperatures enhance tree growth. Several studies have emphasized the important effect of precipitation on tree growth (Shulman and Bryson 1965, Duvick and Blasing 1981, 1983, Holdaway 1987). December precipitation of the previous year was positively correlated with growth in 11 of 16 species-site groups. Kim and Siccama (1987) showed that high winter precipitation enhances tree growth in the northeastern United States. High precipitation in the winter contributes to soil moisture which will support growth resumption in the spring (Broadfoot 1967, Broadfoot and Williston 1973, Gosselink *et al.* 1981).

The significant relationships between June temperature and precipitation and growth of oaks in this area occur when the climate changes from "spring" to "summer" and is about the time when the trees are shifting from spring wood to summer wood production (Fritts 1966). If June is wet and cool, growth is prolonged and if June is hot and dry, ring widths are narrow. The fact that *Quercus lyrata*, one of the most flood tolerant of the oaks studied (Fowells 1965), was significantly related only to temperature suggests that the lower floodplain sites have sufficient moisture for tree growth during the dry years.

The positive growth response to increased river discharge for most of the species-site groups was apparently related to higher precipitation which resulted in the increased discharge. On sites where the relationship was significant, high discharge or flooding was not of sufficient duration to depress tree growth but did reflect an increase in moisture available for tree growth. Stockton (1975) reported that wide rings are associated with increased discharge rates in the western United States. Apparently, duration of flooding on these three sites has been insufficient to inhibit tree growth. Bell and Johnson (1974) found that flooding duration over 30 days was needed to affect tree survival. High discharge during two flood years, 1943 and 1973, lasted about two weeks during April and May, and tree-ring indices show no strong decline in growth. One of the largest floods on record for the Mississippi River occurred in the spring of 1973 and appeared to have little effect on growth of trees at Horseshoe Lake or in Mississippi (Kennedy and Krinard 1976). In fact, growth index of *Q. alba* was relatively high in 1973.

At Horseshoe Lake, the lack of significant correlations with river discharge may relate to the flooding regime of this site compared to Pine Hills and Little Black Slough. The discharge of the Mississippi River is affected by precipitation elsewhere in its large watershed and is less strongly related to local precipitation. Also, the Mississippi River stages are controlled more by snow melt in the upper watershed than by local precipitation. In contrast, the Cache and Big Muddy Rivers are less regulated and have smaller watersheds which respond more to local precipitation. Undoubtedly, levee construction and river flow regulation have affected discharge regimes and floodplain forests. Our understanding of the natural relationships between flooding and growth in floodplain forests is limited by lack of long-term, pre-levee discharge for these river systems.

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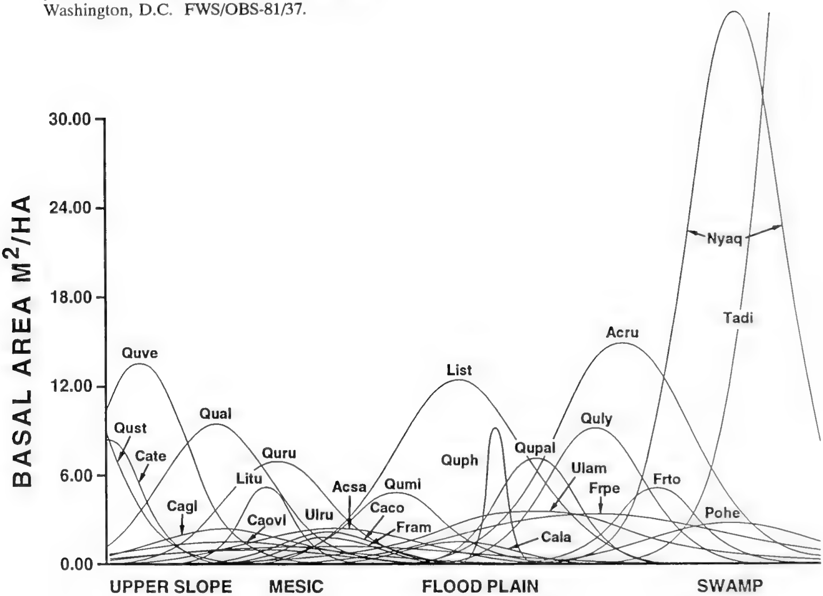

DFL	0.0	0.0	6.9	28.2	52.7	79.2	95.5	98.6	101.4	128.2
CLP	44.0	24.6	29.2	34.4	38.4	41.7	46.2	56.4	56.1	66.9
SILP	30.0	54.4	44.9	37.9	35.3	40.7	36.8	30.3	29.8	17.1
SALP	26.0	21.0	26.2	28.4	27.9	22.6	22.6	16.8	20.5	22.5
CMP	18.9	18.4	17.4	17.0	27.4	38.6	40.7	53.8	54.3	64.9
SIMP	36.6	45.3	49.9	48.9	38.4	39.0	33.8	31.3	29.2	17.3

Figure 1. Coenocline of important overstory species along an upland to swamp gradient in the southern Illinois area. Data are from Horseshoe Lake, Little Black Slough, and Goose Pond in Illinois, and Mingo Wildlife Refuge in Missouri. See Table 2 for abbreviations of environmental factors.

Table 1. Structural characteristics of the vegetation of Little Black Slough, Goose Pond, Mingo Wildlife Refuge and Horseshoe Lake, Illinois.

Attribute	Little Black Slough		Goose Pond		Horseshoe Lake		Mingo WLR	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Tree density stems/ha	486	100-2625	475	225-850	416	50-1675	622	225-2025
Basal area m^2/ha	33.8	7.6-105.4	40.3	7.9-92.4	36.8	6.8-62.0	30.2	12 -57
Tree richness	7	1-13	6.5	1-12	7.4	1-12	8	3-13
N	181		98		129		72	
Study area size ha	100		35		35		32	

Table 2. Overstory basal area (m^2/ha) of major species and means of soil-site variables from TWINSPAN classification of plots from Little Black Slough, Goose Pond, Horseshoe Lake, Illinois and Mingo Wildlife Refuge, Missouri.[a] *Denotes species upon which dominance type is named.

SPECIES	Upper slope	Lower slope	Lower slope/flood-plain	Shallow flood-plain	Floodplain	Deep flood-plain	Swamp	Deep Swamp
Acer negundo		0.07	0.80		0.19	0.33		
A. rubrum			2.34*	0.40	9.64*	13.46*	4.94	0.20
A. saccharum	0.40	2.00*	0.77		0.05			
Carya glabra/ovalis	3.66	2.05	0.08		0.18			
C. laciniosa		0.15	1.04	0.01	0.06	0.05		
Fraxinus americana	1.06	1.00	0.75	0.78	0.03	0.25		
F. pennsylvanica	0.10	0.77	1.80	0.18	1.61	4.29*	2.77	0.04
F. tomentosa			0.15		0.65	3.31*	2.38	0.03
Liquidambar styraciflua	0.18	1.74	11.08*	3.32*	4.28*	0.11	0.14	
Liriodendron tulipifera	0.11	2.20*	0.02					
Nyssa aquatica			0.03		0.24	0.74	24.27*	28.30*
Platanus occidentalis		0.04	1.51	0.02	0.32			0.12
Populus heterophylla			0.05		0.78	0.37	5.15	1.11
Quercus alba	6.24*	3.21*	0.10					
Q. lyrata			1.00	0.94	9.80*	2.15	0.04	0.29
Q. michauxii		1.15	2.00*	1.01	0.11	0.10		
Q. muhlenbergii	0.11	0.94	0.61		0.03			
Q. pagodaefolia	0.10	0.61	1.00		0.01	0.25		
Q. palustris			1.61	6.70*	5.41*	0.52	0.19	0.14

Q. phellos			0.08	12.77*	0.27			
Q. rubra	2.39	4.80*	0.29					
Q. velutina	8.62*	0.09						
Sassafras albidum	0.13	0.73	0.13		0.15			
Taxodium distichum			0.15		2.24	0.55	10.13*	39.28*
Ulmus americana	0.78	0.31	2.69*	1.59	2.77	2.33	0.10	0.14
U. rubra		1.23	0.10	0.99				
Average basal area m^2/ha	29.0	29.3	34.5	27.9	39.7	40.0	50.1	70.6
Soil-site variables[b]								
Clay most permeable	16.5	17.4	34.0	37.2	39.6	52.4	60.5	63.4
Silt most permeable	43.7	50.1	35.9	44.1	36.7	30.5	23.4	20.6
Clay least permeable	23.6	31.4	41.2	38.7	46.0	54.0	61.8	65.6
Silt least permeable	55.6	42.1	37.4	44.2	38.8	29.9	24.2	18.4
Depth least permeable	11.7	28.3	26.5	30.1	21.1	18.9	28.9	8.4
Depth of flooding	0.0	12.4	60.8	50.3	92.4	99.5	100.0	124.0
N	20	167	143	27	45	43	14	30

[a]Minor species include *Aesculus discolor, Asimina triloba, Betula nigra, Carya cordiformis, C ovata, C texana, C tomentosa, Cercis canadensis, Celtis laevigata, C. occidentalis, Ilex decidua, Juglans nigra, Morus rubra, Ostrya virginiana, Prunus virginiana, Quercus shumardii, Q. stellata, Salix nigra, Ulmus alata* and *Vitis spp.* [b]Textural variables expressed in percent; depth variables in cm; most and least permeable refer to the respective soil horizons.

Table 3. — Significant (P $\leq$ 0.05) correlation coefficients from Response Function Analysis of Residual Chronology of Oaks growing on three bottomland sites in southern Illinois in relation to monthly temperature and precipitation at Cairo, Illinois. T = average temperature, P = average precipitation. Underscore indicates coefficient is negative. Priors is number (up to 3) of significant prior years growth. Analysis includes years from 1890 to 1985.

Species/ site groups	Prior growth variance	No. of priors	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Climatic variance
Pine Hills															
Quercus alba	0.8	0		T	P					P	$\underline{T}$P				48.3
Q. macrocarpa	3.00	0			P					P	$\underline{T}$P				39.7
Q. michauxii	11.9	3			$\underline{T}$P					P	$\underline{T}$P				37.4
Q. pagodaefolia	0.6	0		T	P					$\underline{T}$P	$\underline{T}$P	$\underline{T}$			54.8
Q. shumardii	0.0	0			P					$\underline{T}$P	$\underline{T}$P	$\underline{T}$			51.2
Horseshoe Lake															
Q. alba	3.9	0								$\underline{T}$P	$\underline{T}$P			$\underline{P}$	40.1
Q. michauxii	2.6	0			P					$\underline{T}$	$\underline{T}$P				26.3

Q. pagodaefolia	3.8	0								T	TP	T	T		31.9
Q. rubra	6.0	1									T				25.4
Q. lyrata	3.2	0									T				16.2
Little Black Slough															
Q. alba	1.9	0			P					P	TP	T			48.1
Q. michauxii	0.0	0									TP				46.4
Q. pagodaefolia	2.3	1	T		P						TP				41.6
Q. palustris	62.3	3	T		P										12.3
Q. rubra	2.1	0		P								T			32.38
Q. lyrata	0.39	0									T				28.5

A Sampling of Arthropod Diversity From a Central Illinois Woodland

Michael Jeffords and Susan Post

Illinois Natural History Survey
607 E. Peabody Drive
Champaign, Illinois 61820

ABSTRACT

Trelease Woods, a remnant of a much larger forested tract in Champaign County, was sampled six times over a period of several years by walking a diagonal transect across the 60-acre woods and photographically recording any arthropods encountered. Samples were taken during spring, summer, and fall. A summary of the major taxa of arthropods found is included.

INTRODUCTION

Trelease Woods, a 60-acre remnant of the "Big Grove", once occupied 10 square-miles in a bend of the Salt Fork River near Urbana, Illinois. Such forested areas were typically isolated from the main bodies of timber that occurred chiefly along watercourses and were known as "prairie groves." They were believed to have been cut off from larger forested areas by the repeated action of prairie fires and were usually protected by streams, sloughs, or rough morainal lands.

Trelease Woods has been maintained as a natural area for research and educational purposes by the University of Illinois since its acquisition in 1917. It is classified as mixed-mesophytic in composition, with sugar maple (*Acer saccharum* Marsh.) being dominant, followed by hackberry (*Celtis occidentalis*) L., white ash (*Fraxinus americana* L., slippery elm (*Ulmus rubra* Muhl.), basswood (*Tilia americana* L.), red oak (*Quercus rubra* L.), and Ohio buckeye (*Aesculus glabra* Willd.) in order of importance (Boggess 1964). The topography is gently rolling; the maximum difference in elevation is about 4 m. Numerous low areas are found where water stands during wet periods. These stay moist even during the dry months.

This study represents a superficial look at some of the common arthropods found while walking six transects on a diagonal path (Figure 1) through the woods during spring, summer, and fall. Any species of arthropod observed was photographed. The duration of each walk was approximately two hours and occurred over a period of six years, 1986-1992.

RESULTS

Three classes, 13 orders, and 64 families of arthropods were found and photographed during the six walks (Table 1). The above included: 2 orders of diplopods, 2 orders of arachnids, and 9 orders of insects. Identification to the family level revealed 5 familes of spiders (Order Araneida), 1 family of daddy longlegs (Family Phalangiidae), and 59 families of insects. The milipedes were not identified to family.

LITERATURE CITED

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Table 1. Arthropod taxa found in Trelease Woods during study.

- Class Diplopoda
  - Order Polydesmida
  - Order Spirobolida
- Class Arachnida
  - Order Araneida
    - Family Thomisidae
    - Family Salticidae
    - Family Tetragnathidae
    - Family Pisauridae
    - Family Araneidae
  - Order Phalangida
    - Family Phalangidae
- Class Insecta
  - Order Odonata
    - Family Coenagrionidae
    - Family Lestidae
    - Family Libellulidae
    - Family Gomphidae
    - Family Aeschnidae
  - Order Orthoptera
    - Family Tettigoniidae
    - Family Tetrigidae
    - Family Acrididae
  - Order Phasmida
    - Family Phasmatidae
  - Order Homoptera
    - Family Cicadidae
    - Family Flatidae
    - Family Membracidae
    - Family Aphididae
  - Order Hemiptera
    - Family Gerridae
    - Family Phymatidae
    - Family Pentatomidae
    - Family Coreidae
    - Family Miridae
    - Family Lygaeidae
    - Family Reduviidae
  - Order Lepidoptera
    - Family Papilionidae
    - Family Nymphalidae
    - Family Lycaenidae
    - Family Hesperiidae
    - Family Arctiidae
    - Family Saturniidae
    - Family Pterophoridae
    - Family Geometridae
    - Family Lasiocampidae
    - Family Noctuidae
    - Family Sphingidae
    - Family Lymantriidae
  - Order Coleoptera
    - Family Carabidae
    - Family Cincindelidae
    - Family Buprestidae
    - Family Lycidae
    - Family Meloidae
    - Family Cantharidae
    - Family Lampyridae
    - Family Scarabaeidae
    - Family Lucanidae
    - Family Cucurlionidae
    - Family Cerambycidae
    - Family Coccinellidae
  - Order Diptera
    - Family Tipulidae
    - Family Rhagionidae
    - Family Asilidae
    - Family Bombyliidae
    - Family Anthomyiidae
    - Family Syrphidae
  - Order Hymenoptera
    - Family Pelecinidae
    - Family Braconidae
    - Family Sphecidae
    - Family Apidae
    - Family Halictidae
    - Family Megachilidae
    - Family Andrenidae
    - Family Formicidae

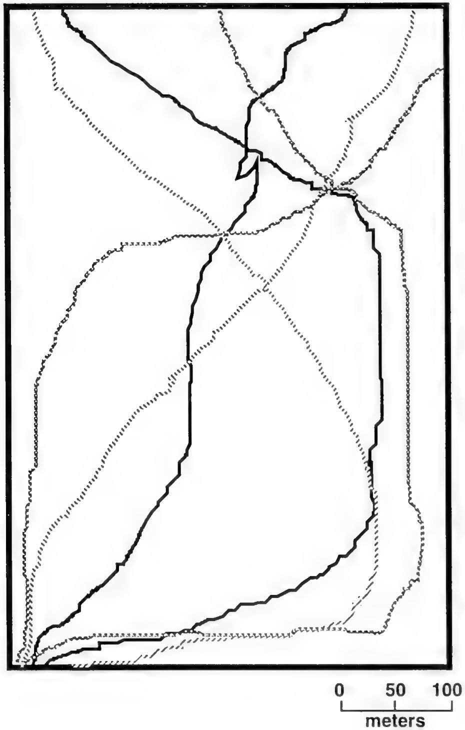

Figure 1. Path of transects through Trelease Woods.

Forest Birds in Illinois: Changes in Abundances and Breeding Ecology

Jeffrey D. Brawn and Scott K. Robinson

Illinois Natural History Survey
Center for Wildlife Ecology
607 East Peabody Dr.
Champaign, Ilinois 68120

ABSTRACT

Forest habitat over much of Illinois is a series of loosely connected or isolated woodlots. Fragmentation adversely affects the viability and persistence of many songbird populations, especially neotropical migrants (*e.g.*, warbler and vireos). Here, we discuss two aspects of fragmentation and Illinois' songbirds: long-term trends in the breeding abundances in east central Illinois and reproductive success in central and southern Illinois. Bird populations and communities have clearly changed during the 20th century, but we found considerable variation among species in trends of abundance. As a group, neotropical migrants appear to be less common now than they were 50 years ago. Nesting success of birds breeding within woodlots is characteristically low (*e.g.*, < 40%) owing to high rates of predation. Fecundity is further reduced by brood parasitism by Brown-headed Cowbirds (*Molothrus ater*). Data on immigration from and emigration to local populations are critical for understanding the dynamics of Illinois' wildlife populations.

INTRODUCTION

Large contiguous tracts of forest habitat seldom persist in areas that are intensively farmed or urbanized. Illinois is no exception, where only 31% of the forest cover present in 1820 remains today (Iverson *et al.* 1989). Whereas the extent of deforestation varies among the state's regions, even moderately large (*i.e.*, 2000 ha) tracts of forest are primarily restricted to southern Illinois. Habitat for forest wildlife over much Illinois has therefore been reduced to a series of loosely connected or isolated woodlots, a condition referred to as fragmentation.

Fragmentation is known to affect communities and populations of forest birds. In general, abundances of forest birds vary inversely with the extent of local fragmentation. During the breeding season, few species are found within small fragments of forest habitat (*e.g.*, less than 2 ha). Species vary in their sensitivity to fragmentation and a large proportion of permanent resident species persist even in the most intensely fragmented areas of the state (Kendeigh 1982). In contrast, many species of neotropical migrants such as warblers and vireos that winter in Central and South America are among the most sensitive to fragmentation and abundances of these species have declined in certain parts of their breeding ranges (Terborgh 1989, James *et al.* 1992).

Decreased species richness in fragmented landscapes can stem from simple habitat loss or more subtle effects such as increased rates of nest predation and brood parasitism (Martin 1992, Robinson 1992). With time, these factors may promote local extinctions or reduce the viability of resident populations to the point where their persistence is maintained only by immigration from more productive regions (Temple and Cary 1988, Robinson 1992).

Here we report on certain aspects of our studies of forest birds and fragmentation in Illinois. We present results organized about two research questions: 1) what are trends in abundances and community structure of forest birds in Illinois? and 2) what rates of nest success are forest birds experiencing and how important are nest predation and brood parasitism?

METHODS

Long-term data are essential for analyses of temporal trends in populations because abundances of birds fluctuate through time even under the best of ecological conditions. A formidable challenge is to discriminate this "background variation" from unusual trends that signal a need for intensive study and conservation measures. Owing to the work of the late Dr. S. Charles Kendeigh (University of Illinois), studies of forest birds in the heavily farmed landscapes of east-central Illinois extend back to the late 1920's and, in some cases, were continued through the mid-1970's (see Kendeigh 1982). In 1992, one of us (JB) began to census birds on two of Kendeigh's former study areas: Trelease Woods and Allerton Park. Trelease Woods is a 24 ha woodlot surrounded by agricultural land and located in Champaign County. The Allerton Park study area is a 24 ha plot within a 600 ha forest located in Piatt County. Data on breeding birds are considerably more comprehensive for Trelease Woods.

We chose these areas because of the duration and "reach" of Kendeigh's data. Most data on breeding bird communities elsewhere in the state extend back only to the mid-1960's. We believe that data from the areas are representative for forest birds within intensively farmed areas, but trends in different regions may vary significantly. The information presented here includes all of Kendeigh's data and the 1992 census.

Two trends are considered in the report; numbers of species found breeding and relative abundances of neotropical migrants. For the latter trend, relative abundances (*i.e.*, the percentage or proportion of all birds detected in a given area) were used because of differences in the census methods used by us (point counts, see Hutto *et al.* 1986) and Kendeigh (spot-map, see Kendeigh 1944). The two estimates, however, should be similar because the point count method we used generates distributional maps. Efforts are currently underway to reconcile these differences and analyses will be presented elsewhere.

To estimate rates of nest success, we attempted to locate nests throughout the breeding season. The data reported here are primarily from studies around Lake Shelbyville in Moultrie and Shelby Counties and in the Jonesboro Ranger District, Shawnee National Forest. Forests in the former areas form an archipelago of woodlots that border the lake and are surrounded by agricultural land (see Robinson [1992], for a more detailed description of study sites). The woodlots were generally small, ranging up to 65 ha. Tracts in the Shawnee National Forest ranged from 1100 ha (South Ripple Hollow) to 2000 ha (Pine Hills). When possible, we determined the fates of located nests by checking them 2-3 times weekly. Daily survival rates of nests were estimated using the Mayfield method, which minimizes sampling bias (Mayfield 1975).

RESULTS and DISCUSSION

<u>Trends in abundances</u>. - Numbers of species breeding did not decrease appreciably within either Trelease Woods or Allerton Park. Annual fluctuations were common, but we detected no systematic decrease (Figure 1). In fact, numbers of species breeding within Trelease woods increased during the 1950's and have remained greater than those recorded during the early census years. Species richness within Trelease Woods was especially low during the early 1940's. Data are comparatively sparse for Allerton Park, but the number of species recorded in 1992 was slightly greater than that found during the previous 6 census years (Figure 1).

Effects of woodlot size were evident in comparisons of Trelease Woods and Allerton Park. Total numbers of breeding species were similar on the two areas, but neotropical migrants were consistently more diverse within Allerton Park. With the exception of edge species such as Indigo Buntings (*Passerina cyanea*), all species typical of Trelease Woods were also found in Allerton Park. Several species, however, were found only within Allerton Park, including neotropical migrants such as Blue-gray Gnatcatchers (*Polioptila caerulea*), Ovenbirds (*Seiurus aurocapillus*), and American Redstarts (*Setophaga ruticilla*). Numerous studies have found these species to be absent from small woodlots (Blake and Karr 1987, Hayden *et al.* 1985). Whereas the ecological mechanisms underlying "area sensitivity" are not completely understood, it is clear that large tracts of forest are needed to preserve regional species diversity of forest birds.

<u>Relative Abundances of Neotropical Migrants.</u> - We

detected trends in the relative abundances of neotropical migrants within both study areas. When analyzing relative abundances, we found it necessary to factor out the effects of Brown-headed Cowbirds (*Molothorus ater*) and European Starlings (*Sturnus vulgaris*). These species have increased significantly throughout Illinois and the Midwest since the beginning of Kendeigh's studies.

From the late 1920's through the mid-1950's, relative abundances of neotropical migrants (collectively) were commonly above 50% and ranged as high as 70%. After this period, relative abundances of the migrants were never > 50% and were as low as 28% in 1973. This seeming "break point" stemmed in large part from sharp decreases (> 50%) in Indigo Buntings and Red-eyed Vireos (*Vireo olivaceus*). We also detected slight decreases in Great Crested Flycatchers (*Myiarchus crinitus*) and Eastern Wood-Pewees (*Contopus virens*). No species of migrant became more common during this period.

Relative abundances of migrants were greater within Allerton Park than in Trelease Woods. Nonetheless, we observed a similar pattern over time within both areas. Decreases in relative abundances of the migrants in Allerton were also evident in the late 1950's or early 1960's (Figure 2). Migrants accounted for over 65% of the breeding birds counted on the plot from 1949-1951, but decreased to less than 50% during the last three census years. Species undergoing comparatively sharp decreases within Allerton Park included Kentucky Warblers (*Oporornis formosus* - 43%), and American Redstarts (88%).

In sum, most species of neotropical migrants have persisted on the study areas during the census periods, but it appears that several are decreasing - even within comparatively large tracts of forests. The ecological factors underlying these decreases are unclear. Loss of habitat at wintering grounds may be influential (Terborgh 1989, Greenberg 1992), but we believe that events during the breeding season are also involved (see below).

Another factor may be structural changes in the forests. Effects of successional changes within and near the study areas on resident birds communities are discussed at length by Kendeigh (1982). One possibility (also pointed out by Kendeigh) is the demise of American Elms (*Ulmus americana*) in the 1950's. Loss of elms opened up the canopy and undoubtedly affected the availability of foraging substrates, food, and potential nest sites. For some species such as woodpeckers, the die-off enhanced populations. The coincident loss of elms and declines in relative abundances of several migrants is not generally appreciated and merits further study.

Nesting Success: Lake Shelbyville. The first indications that forest fragmentation causes problems for nesting migrants in Illinois came from a preliminary study of small (<70 ha) woodlots surrounding Lake Shelbyville in Shelby and Moultrie counties. Nesting success of most Neotropical migrants in these woodlots was almost too low to measure as a result of high levels of nest predation (>80% of all nests) and cowbird brood parasitism (76% of all nests) (Robinson 1992). Wood Thrushes (*Hylocichla mustelina*) were particularly hard hit; clutches averaged 4.6 cowbird eggs and only 1.2 host eggs per nest. On average, 10 Wood Thrush nests produce only a single fledgling, a rate of productivity far less than that necessary to compensate for adult mortality (Robinson 1992). As a result, these Shelbyville woodlots were likely to be population "sinks" (sensu Pulliam 1988) for the Wood Thrush and possibly, for most other forest-dwelling Neotropical migrants. The Shelbyville Wood Thrush population is probably maintained only by immigration from "source" populations, which may be located hundreds of kilometers away in more extensively forested areas such as the Ozarks and Hoosier National Forest in Indiana. The only two forest species that experienced moderate (30-60%) levels of nest predation and parasitism were the ground-nesting Ovenbird and Kentucky Warbler. Most ground-nesters in Illinois hide their nests extremely well and may be less affected by fragmentation than shrub-and canopy-nesting species.

Results from larger (1000-2000-ha) tracts in the Shawnee National Forest showed similar, albeit less extreme problems with nesting success of Neotropical migrants (Table 1). Cowbird parasitism and nest predation levels were high throughout the forest with no appreciable or consistent decline even 600 m from nearest edge (Figure 3). These results contrast with those from Wisconsin (Temple and Cary 1988) and Maryland (Gates and Gysel 1978)

where predation and parasitism levels began to decline dramatically 200m from the nearest edge. Once again, the Wood Thrush suffered the highest levels of parasitism with at least 75% of all nests parasitized at all of the major study sites (C.L. Trine, unpubl. data). Given current estimates of adult and juvenile survival, it is unlikely that most Wood Thrush populations in the Shawnee National Forest (C.L. Trine, unpubl. data) or in northwestern Illinois (R. Jack and S.K. Robinson, unpubl. data) produce enough young to compensate for adult mortality. The recent declines of Wood Thrushes in small woodlots (Robinson 1992) and state-wide (C.L. Trine, unpubl. data) may be caused by high levels of brood parasitism and nest predation. Other species suffering from high (>70%) predation and parasitism levels include the Scarlet (*Piranga olivacea*) and Summer (*P. rubra*) tanagers, Hooded Warblers (*Wilsonia citrina*), and Red-eyed Vireo. Several other species such as the Acadian Flycatcher (*Empidonax virescens*) and Worm-eating Warbler (*Helmitheros vermivorus*) are abundant throughout the forest and suffer relatively little from predation or parasitism (Table 1).

In contrast to the apparent vulnerability of many forest species, most edge and second-growth species appear to be resistant to cowbird parasitism. American Robins (*Turdus migratorius*), Gray Catbirds (*Dumetella carolinensis*), and Northern Orioles (*Icterus galbula*) all reject cowbird eggs. Prairie Warblers (*Dendroica discolor*), Bell's Vireo (*Vireo bellii*), Indigo Buntings, and Yellow Warblers (*Dendroica petechia*) abandon some, although not all parasitized nests. Other edge species that are rarely parasitized include the Yellow-breasted Chat (*Icteria virens*), Blue-winged Warbler (*Vermivora pinus*), Red-winged Blackbird (*Agelaius phoeniceus*), White-eyed Vireo (*Vireo griseus*), and Chipping (*Spizella passerina*) and Field (*S. pusilla*) sparrows. The only heavily parasitized second-growth species we have found is the Orchard Oriole (*Icterus spurius*), which is only heavily parasitized in parts of the state (D. Enstrom and S. Robinson, unpubl. data). Problems with cowbird parasitism therefore appear to be most severe in forest-nesting species.

Unanswered Research Questions. - Major questions provoked by these results involve interspecific variation in persistence and seeming viability within fragmented landscapes. Specifically, are demographic processes different for persistent and sensitive species? We know that the productivity of many species within woodlots is consistently below replacement level. Yet, most of these species are reliably present within these woodlots. As mentioned above, immigration from more productive areas is a possibility, but we have very few data on natal dispersal. The scale of the so-called "source-sink" dynamic is virtually unknown for birds and could vary substantially for migrant versus permanent resident species. Estimating dispersal distances with telemetry is a possibility and pilot studies are being planned by personnel at the Illinois Natural History Survey. Data from these studies will be mandatory for understanding and defining populations of wildlife in agricultural and urban landscapes.

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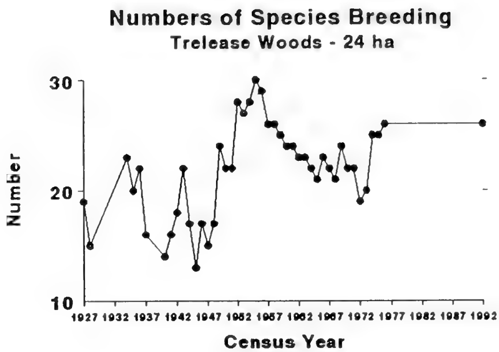
Table 1. Nest parasitism and predation rates for the Pine Hills study area, 1989-1991, Jonesboro Ranger District, Shawnee National Forest. All nests were located within 2.0 km of the Pine Hills campground.

Species	% Parasitized (n)[1]	% Depredated (n)[2]
Acadian Flycatcher	31.8 (85)	43.2 (1343)
Wood Thrush	90.0 (150)	53.5 (2048)
Kentucky Warbler	48.1 (52)	72.3 (399)
Worm-eating Warbler	40.0 (5)	--
Indigo Bunting	53.8 (13)	59.0 (150)
Northern Cardinal	40.0 (20)	82.9 (222)

[1]Number of nests located.
[2]Number of exposure days (Mayfield 1975).



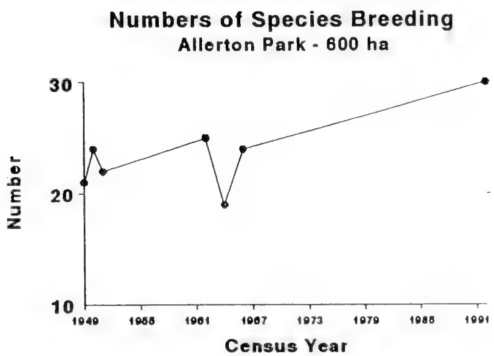
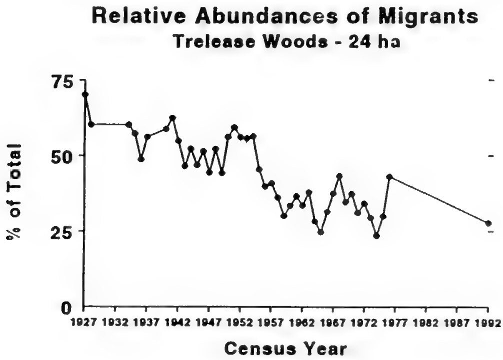


Figure 1. Numbers of songbird species found breeding within two woodlots in east central Illinois.



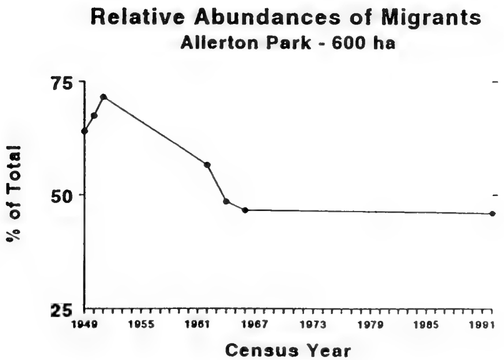


Figure 2. Relative abundances of neotropical migrants within two woodlots during the breeding season.

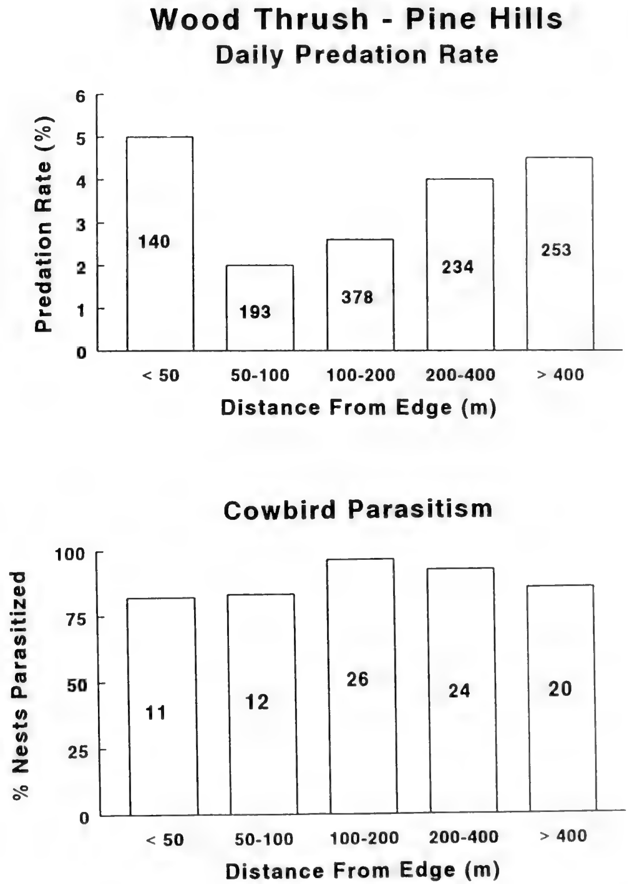


Figure 3. Cowbird parasitism and daily nest predation levels in relation to distance from edges of openings of at least 0.5 ha, 1989-1990, in the Pine Hills study site. Numbers in bars on top graph indicate exposure days (see text). Numbers in bars on bottom graph indicate number of nest within each interval.

Effects of Riparian Buffers in Reducing Agricultural Pollution in Champaign County, Illinois

David A. Kovacic and Lewis L. Osborne

Department of Landscape Architecture and
Department of Forestry
University of Illinois

and

Illinois Natural History Survey
607 East Peabody Dr.
Champaign, Illinois 68120

ABSTRACT

The effectiveness of riparian vegetation in reducing nutrient losses from an upland terrestrial system dominated by rowcrop agriculture was examined. Nitrate concentrations in soil water at three subsurface depths (60 cm, 120 cm, and > 120 cm) from a perennial grass buffer composed of Reed Canary Grass (*Phalaris arundinacea*) and a forested buffer dominated by mature Cottonwoods (*Populus deltoides*) were compared to a cropped treatment with no buffer. Dramatic reductions of nitrate-N occurred in both the forested buffer and grass buffer. The 18 m wide riparian buffer reduced nitrate-N 85-95%. The 67 m wide grass buffer reduced nitrate-N 69-85%. Riparian vegetated buffer strips may be used as effective tools in reducing nutrient transport from agroecosystem uplands to adjacent surface waters. Riparian buffer strips may be effective when used at the watershed scale to improve surface water quality.

INTRODUCTION

Agricultural lands are highly modified ecosystems (Conway 1987) that characteristically "leak" nutrients (Loucks 1977). As a result, agriculture has been implicated as the major land use contributing to nonpoint source (NPS) degradation of surface waters in the United States (Humenik *et al.* 1987, Odum 1989). It has been estimated that 44% of the 4.2 million metric tons of nitrogen fertilizer (as N) applied in the Mississippi River watershed between 1981-1985 was lost or "leaked" into the Gulf of Mexico (Turner and Rabalais 1991). One reason for the correlation between agriculture and water quality degradation is the industry's reliance on nitrogen fertilizer (Omernik 1976, Farnworth *et al.* 1979, National Research Council 1982). Typically, 168 kg ha-1 (150 lbs. acre-1) as nitrogen are applied to the Midwest cornbelt. Although nitrogen is usually applied in the form of ammonium which is relatively immobile in soil, it is rapidly converted by nitrifying bacteria to nitrate. Nitrate is highly mobile in the soil and rapidly leached under wet conditions. As a result, concentrations in central Illinois streams often exceed 10 mg nitrate-N L^{-1} (the EPA's standard for safe drinking water). Consequently, many drinking water reservoirs exceed the safe drinking water nitrate limits at certain times of the year (*e.g.*, Lake Vermilion near Danville, Illinois and Lake Decatur in Decatur, Illinois).

Odum (1989) states that NPS can only be controlled by input management; that is, reducing the amount of agricultural chemicals applied to crops. He further states that past production has focused on increasing yields by increasing fertilizers without much regard to efficiency or the amount of resulting NPS pollution. Agriculturalists as well as environmentalists recognize the need for input management and strategies to decrease N losses from croplands to surface waters. A major obstacle to improving N fertilizer management is the accurate

prediction of the soil's capacity to supply N to the crop (Saint-Fort *et al.*, 1990). This problem occurs because the dynamics of N in the environment are complex and the number of cultural and environmental factors that can alter N availability are many.

Although input management will reduce losses of NPS nitrate it will probably never be the sole solution to nitrate pollution. Multiple strategies will require a combination of techniques to control water quality including input, output and land use management. One management alternative recommended by several authors is the use, maintenance, and restoration of vegetative stream-side buffer strips in agricultural regions (e.g., Cooper *et al.* 1986). The fundamental objective behind this practice is to reduce nutrient export to surface waters by increasing nutrient cycling, retention time, and the rate of denitrification in the watershed.

Stream-side vegetation has been shown to be important in maintaining stream water quality (Moring 1975, Borman and Likens 1979, Cooper *et al.* 1986, Osborne and Wiley 1988). Research in the eastern United States indicated that riparian vegetation acted as a filter for Ca, Mg, K, sulfate-S and NO_3^--N (Lowrance *et al.*, 1984, Peterjohn and Correll, 1984) and that filter-strips of 18 m in width could effectively reduce NO_3^--N inputs (Cooper *et al.* 1986). There remain some questions about the efficiency of different vegetated buffer strips. Despite the apparent benefits of riparian buffer strips on Coastal Plain soils, little work has been done on buffer strips effectiveness in agricultural soils of the Midwestern cornbelt.

Recognizing the need to develop effective methods to reduce NPS pollutants from agricultural lands, we examined the role of riparian vegetation in mitigating nutrient losses from a Midwestern upland terrestrial agroecosystem dominated by row crop agriculture. In this study we asked two main questions: 1) Are vegetated riparian buffer systems effective in reducing nitrate transport from terrestrial to aquatic systems in loess derived soils of the Midwest; and, 2) If vegetated filter strips are effective, do riparian forests differ from grassland sites in their ability to reduce nutrient transport to surface waters.

DESCRIPTION OF STUDY SITE, RESEARCH DESIGN AND METHODS

The study site on the East Branch of the Embarras River in southeastern Champaign County, Illinois is located within the Central Corn Belt Plains Ecoregion, a low relief glacial till plain overlain with loess. The dominant soil association is Drummer-Kendall-St. Charles which overlies a dense basal till. Much of the area is tile drained with exceptions being the two riparian buffers utilized in this study. The predominant land use is row crop agriculture. Agricultural practices contribute to stream nitrate-N levels periodically in excess of the EPA standard (10 mg nitrate-N L^{-1}). Using U.S.G.S. discharge and water quality data from January 1989 to May 1990 at Camargo sampling station on the Embarras River (24 km south of the study site) nitrate-N loading was estimated at 492 metric tons. This is an average of 1.5 metric tons nitrate-N per kilometer over a 326 km stream length.

The site was divided into an upland zone planted in a corn/soybean rotation and a riparian zone divided into the three following treatments paralleling the west bank of the Embarras River: 1) rowcrops planted down to the stream bank; 2) a riparian forest (approximately 18 meters wide) dominated by 70 year-old cottonwood trees (*Populus deltoides*) and silver maple (*Acer saccharinum*); and, 3) a 67 meter wide strip of Reed Canarygrass (*Phalaris arundinacea*) between the stream and rowcrops.

Within each riparian treatment (rowcrop, forest, and perennial grass) three lysimeter transects, 15 meters apart, were installed perpendicular to the stream channel to follow the sub-surface lateral movement from the upland site toward the stream. Lysimeter transects on each treatment consisted of a center row of five paired lysimeters placed at 60 cm (shallow lysimeters) and 120 cm (deep lysimeters) below the soil surface. Piezometers were installed (>120 cm, see below) in the center transect of the first, third, and fifth row in close proximity to the paired lysimeters. This design allowed the monitoring of the downward and lateral movement of nutrients in sub-surface flow from the cropped upland to the stream through the different riparian zones. Osborne and Kovacic (1993) give a detailed description of the sampler construction, placement, sampling design and sample analysis procedures.

RESULTS AND DISCUSSION

There was no significant difference in nitrate-N concentrations among shallow lysimeters in the upland and riparian crop sites. In the two other cases (*i.e.*, the forest and the grass sites) the concentrations of nitrate-N in ground water in the upland crop areas were significantly higher than were mean concentrations at comparable sampling depths in the riparian zone (Figure 1). The significant reductions in nitrate-N concentrations from the upland crop zone to the RBS (Riparian Buffer Strip) suggest that nitrates were being removed from the system. Denitrification in RBS has been suggested as the primary mechanism for the reduction of nitrate concentrations in solution (Cooper *et al.*, 1986). Others have also provided evidence that denitrification is an important mechanism contributing to the loss of nitrate-N. Bromide used as a tracer verified that subsurface groundwater moved laterally from the cropland through the forest and grass buffer strips to the stream.

In the riparian zone, concentrations of nitrate-N in shallow lysimeters were significantly greater in the grass RBS (2.43 $\pm$0.43 mg L^{-1}) than in the forested RBS (0.87 $\pm$0.23 mg L^{-1}, Figure 1). There were no significant differences in nitrate-N concentrations in solution between the forest and grass RBS at 120 cm and >120 cm (Figure 1). It is noteworthy that between the 60- and 120-cm depths the greatest proportional decrease in nitrate-N concentration (77.5%) occurred in the riparian crop site (*i.e.*, from 16.86 $\pm$2.29 mg L^{-1} at 60 cm to 3.79 $\pm$1.22 mg L^{-1} at 120 cm, Figure 1). The proportional decreases between the 60- and 120-cm depths in the forest and grass RBS (34.0 and 51.0%, respectively) were substantially lower than in the riparian crop site (Figure 1). In the riparian crop sites the greater loss of nutrients in solution between the 60- and 120-cm depths is attributable to subsurface transport in drainage tiles directly to the stream channel, rather than to denitrification and plant uptake.

The evidence suggests that RBS can reduce N inputs to streams in Midwest agricultural systems. Osborne and Wiley (1988) concluded that the mitigating benefits of RBS will be maximized if they are sited in the smaller headwater streams whose lengths dominate any drainage network. In much of the Midwest, most lands in the headwaters of the catchment are privately owned. Undoubtedly, government support incentives will be required for large scale adoption of RBS in many regions of the U.S.

In areas that are tile drained the effectiveness of riparian buffer strips in removing nitrate-N will be reduced as nitrate-N is shunted past the RBS. One solution to this problem is to remove the tiles; however, this is not a viable solution because it would render the land unfarmable. Another more viable solution would be the creation of small wetlands fed by agricultural drainage and designed to optimize nitrate-N removal through plant uptake and denitrification. We are now studying the efficiency of artificial constructed wetlands for removing nitrate-N in lowland areas that are tile drained. To create such wetlands, tile drains are surfaced upland (sunlighted) rather than laid directly to the stream (Figure 2). A berm is created adjacent to the stream (width of berm and distance from stream depend on the size of the drainage basin) to cause water to pool and thus increase retention time. It is anticipated that nutrient removal will occur in a fashion similar to that of RBS and natural wetlands (Lee *et al.*, 1975). Preliminary investigations indicate that constructed wetland buffers with a 1:20 wetland to drainage area ratio could effectively treat 65% of the water entering them for 5 days and 55% for 15 days.

We believe that RBS and constructed wetlands can effectively reduce the movement of nitrate-N from croplands to agricultural surface waters. Riparian buffer strips and constructed wetlands are two techniques that should help meet the needs of both the farmer and the Federal government by: 1. Supporting non-tiled and tiled croplands; 2. Improving water quality through the natural biological processing of nitrate; and, 3. Reestablishing wetlands and riparian corridors in areas where they once existed. It should, however, be recognized that no single method or technique will eliminate all nitrate-N input into surface waters, nor will it be universally applicable in every water quality mitigation program. A combination of options must be considered for any comprehensive water quality program, these options should include RBS, constructed wetlands, changes in farming practices such as no-till agriculture and fertilizer

input management.

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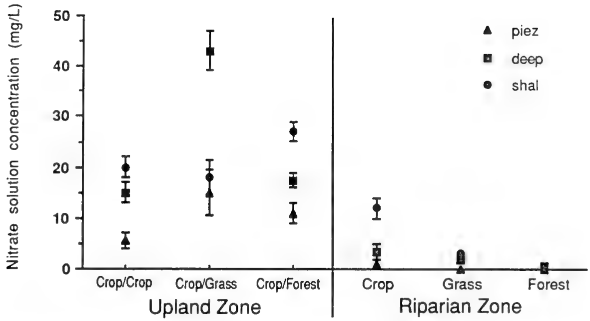

Figure 1. Mean concentrations of nitrate-N in solution from shallow and deep lysimeters, and piezometers in each adjacent upland crop zone and each riparian (crop, grass and forest) zone during the study. (crop/crop = cropped upland adjacent to the cropped riparian zone, crop/grass = cropped upland adjacent to the grassed riparian zone, crop/forest = cropped upland adjacent to the forested riparian zone)

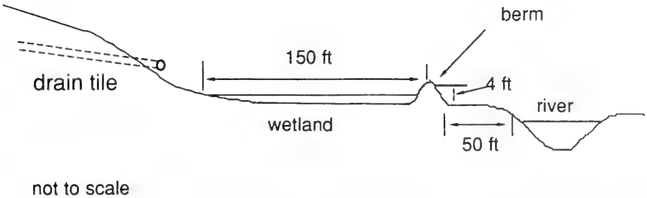

Figure 2. Conceptual design of a constructed wetland buffer for facilitating the removal of nitrate-N from agricultural drainage water.

Endangered and Threatened Animal Species of Illinois Forests

James R. Herkert

Illinois Endangered Species Protection Board
524 South Second Street
Springfield, Illinois 62701-1787

Due to the structural complexity of forest ecosystems, forests support a diverse array of plant and animal species. In fact, although forests covered only 38% of the presettlement land area in Illinois (Iverson *et al.* 1989), Graber and Graber (1963) estimated that forests supported perhaps as much as 55-60% of the state's presettlement bird fauna. Due to the great variety of organisms that occur in Illinois forests, the conservation and protection of the state's forest resources and their dependent species is an important component of preserving the natural diversity of Illinois. At least 115 native plant and animal species are presumed extirpated in Illinois (Post 1991), of which 36 (roughly 31%) of these species could be considered forest species.

The list of extirpated forest animal species includes some high-profile species that are probably well known to many residents of the state, such as the wolf (*Canis lupus*), elk (*Cervus canadensis*), mountain lion (*Felis concolor*) and black bear (*Ursus americanus*), (Hoffmeister 1989). Species that were all once relatively common and widespread in Illinois - but were eliminated sometime between 1850 and 1900 (Hoffmeister 1989).

A few of these extirpated Illinois forest animal species are now globally extinct, such as the passenger pigeon (*Ectopistes migratorius*) and Carolina parakeet (*Conuropsis carolinensis*). Once arguably the most abundant bird in the world, the passenger pigeon was an inhabitant of deciduous forests throughout the eastern United States (Ehrlich *et al.* 1988). Audubon once wrote of having watched a single flock pass overhead for three consecutive days and estimated that at times more than 300 million birds flew by each hour. Unregulated slaughter, however, very quickly drove this species to the brink of extinction. The passenger pigeon apparently last bred in Illinois in 1893 (Bohlen 1989), and the last known individual died in captivity in the Cincinnati Zoo in 1914 (Ehrlich *et al.* 1988). The Carolina parakeet, also an inhabitant of mature deciduous woodlands, was once relatively common in southern and in parts of central Illinois. However, Carolina parakeets were persecuted as agricultural pests and were rapidly wiped out due to "pest control" measures, sport hunting, and habitat destruction and degradation. The last Illinois sighting of a Carolina parakeet was in 1912 (Bent 1940).

Other former Illinois forest species are nearly extinct, such as the ivory-billed woodpecker (*Campephilus principalis*). The ivory-billed woodpecker once inhabited mature forested swamps and mature river bottoms in the southeastern United States and is now believed to be extinct in the United States and found only in a few remote areas of Cuba (Ehrlich *et al.* 1988). There are only three known records for the ivory-billed Woodpecker in Illinois, the last of which occurred in the fall of 1900 (Bohlen 1989).

Several other species have disappeared from Illinois with little fanfare and are probably unknown to most residents of the state. The reasons for the disappearance of these forest species are varied, but loss and degradation of habitat, and direct human exploitation, are probably the greatest factors. Many of these species (at least for the vertebrates) were lost by 1900, almost 100 years ago (Hoffmeister 1989, Bohlen 1989).

Somewhat surprisingly, it appears that relatively few animal species have been lost from Illinois in the last fifty years. During this period, however, a tremendous number of species have been pushed to the brink of elimination from the state. Presently there are 500 species of plants and animals that are listed as either Endangered or Threatened in Illinois (Herkert 1991, 1992). By definition that means that roughly 21% of the state's resident vertebrate

species and 18% of the state's plant species (excluding Bryophytes) are presently in danger of extinction in Illinois or are likely to become in danger of extinction in the foreseeable future. Of the 500 state-listed species 356, or roughly 70%, are plants and 144, or about 30%, are animals. A majority of state listed plant species are inhabitants of forest habitat (Figure 1), whereas for animals the majority of state-listed species occur in aquatic habitats (Figure 1). For forest species, there are 161 plant and 33 animal species listed as either Endangered or Threatened in Illinois. Of the 33 state-listed forest animal species, nearly half are birds (Table 1). Over one-third of all birds listed as either Endangered or Threatened in Illinois are inhabitants of forest habitat. Similar numbers for other groups are 80% for state-listed mammals, 55% for Reptiles, 66% for Amphibians, and less than 1% for Invertebrates.

The list of Endangered and Threatened forest animal species in Illinois (Table 1) ranges from the relatively obscure to the majestic - from the Iowa pleistocene snail to the Bald Eagle. The Iowa pleistocene snail, a federally endangered species, is known in Illinois from only one population in the northwestern part of the state. The bald eagle, also a federally endangered species, is a fairly common winter and rare summer resident in Illinois (Bohlen 1989). In January, 1992, the state's mid-winter bald eagle survey recorded nearly 2000 bald eagles in the state. Illinois also has an increasing nesting population of Bald Eagles. In 1992, there were at least 11 active eagle nests in Illinois, including the first nesting attempt in the Illinois River valley in more than 40 years.

Somewhat surprisingly the number of Endangered and Threatened forest animal species per county in Illinois is only moderately correlated with the total amount of forest cover in that county ($r=.45$, $p < 0.01$). Counties with high numbers of Endangered and Threatened forest animal species include Johnson (14), Alexander (11), Pope (10), Pulaski (9), Union (8), Carroll (7), and Pike (7) (Figure 2). For comparison, the relationship between the number of state-listed forest plant species per county and the total amount of forest cover in that county is even weaker than the relationship for animal species ($r=.35$, $p < 0.01$). Counties with more than 10 state-listed forest plant species are Pope (34), Lake (20), Jo Daviess (19), Cook (19), Union (19), Johnson (17), Ogle (17), Massac (15), Alexander (14), Jackson (12), and Pulaski (12).

In terms of numbers, roughly 40% of all Endangered and Threatened forest animal species in Illinois are known to occur at five or fewer locations in the state. Four of these species have been found in only a single location in the state. One of these species, the eastern woodrat, may be the most imperiled forest animal in the state. In Illinois, eastern woodrats are presently known only from the cliffs and talus slopes of the Pine Hills in southern Illinois (Union County). Recent population estimates (based on nest counts) for the Pine Hills population show that the population of woodrats at this site probably reached an all time low in 1990, with perhaps fewer than 20 animals inhabiting the area (Herkert 1992). Other forest species known from only a single location in Illinois are the great plains rat snake, green water snake, broad-banded water snake and silvery salamander. The broad-banded water snake may be extirpated in Illinois (Post 1991) and was last seen in the Horseshoe Lake area (Alexander County) in the mid-1950s (Herkert 1992).

In contrast to the rarity of the aforementioned species, three state-listed forest animal species are known from more than 30 sites in Illinois - the river otter, bobcat and great egret. The river otter was relatively common and widespread in Illinois prior to extensive European settlement (Cory 1912, Mohr 1943); but had become scarce by the mid-to-late 1800s and was considered to be completely extirpated from Illinois by the early 1940s (Brown and Yeager 1943). River otters have recently been reported from 33, or roughly one-third, of the counties in the state (Herkert 1992), yet the actual status of this species in the state is uncertain. There is an established breeding population in the northwestern part of the state in Jo Daviess, Carroll and Whiteside counties (Anderson and Woolf 1984). There also appears to be a breeding population in the southern part of the state in the Cache River area (Anderson and Woolf 1984). For the remaining records, however, it is not clear whether these represent dispersing individuals or small isolated breeding populations.

The bobcat was also once fairly common in the timbered areas throughout Illinois at the time of

settlement (Wood 1910, Cory 1912, Mohr 1943) but began to disappear from most of the northeastern and central sections of the state soon after settlement. By the mid 1900s the conversion of many woodland areas to cropland and pastureland, along with mining, logging, and draining of woodland swamps, in addition to persecution as a destructive predator, had driven the bobcat to the brink of extirpation in the state (Brown and Yeager 1943, Hoffmeister 1989). Bobcat numbers in Illinois have remained fairly low and, as recently as 1989, Hoffmeister (1989) listed only 14 recent bobcat records from 13 Illinois counties. Since 1980 bobcats have been sighted in nearly 40 locations from 19 Illinois counties (Illinois Department of Conservation, Natural Heritage Database).

The Illinois breeding population of great egrets has fluctuated greatly in modern times (Graber *et al.* 1978). In the early and mid 1800s great egrets were considered somewhat common in Illinois (Ridgway 1895, Barnes 1926). By the late 1800s, however, the state's breeding population had been seriously depleted, primarily due to plume hunters (Woodruff 1908, Barnes 1912, 1926). By 1921 this species was considered to be probably extirpated as a breeding species in Illinois (Musselman 1921). Isolated reports of breeding great egrets began to reappear in the early 1930s (*e.g.*, Jones 1937, Bellrose 1939) and the state's population continued to increase at least into the 1950s (Graber *et al.* 1978). Graber *et al.* (1978), however, found that great egret numbers in the 1970s were again declining. The state's population of great egrets may have declined by as much as 80% during the 1970s (Graber *et al.* 1978). Presently, the Illinois population of great egrets is apparently increasing again. In 1991, there were 32 active great egret colonies in Illinois, 15 with fewer than 15 nests, eight with 50-100 nests, and eight with more than 100 nests (Herkert 1992).

The protection of areas in which state-listed forest animal species occur has proved to be more difficult that protecting areas of occurrence for state-listed plant species. Nearly 54% of all known locations for Endangered and Threatened forest animal species in Illinois are on private land. This is considerably higher that similar numbers for Endangered and Threatened forest plant species. Only 30% of all known locations for Endangered and Threatened forest plant species in Illinois are on private land. Slightly more than one-third of all known locations for state-listed forest animal species are somewhat protected by public ownership, but only 11% occur within dedicated State Nature Preserves. Comparatively, 48% of all known locations for state-listed forest plant species are in public ownership and 22% are within dedicated State Nature Preserves.

In summary, the outlook for Illinois' Endangered and Threatened forest animal species is uncertain. A few species are showing definite signs of recovery and some others are exhibiting weak signs of improving. Many other species, however, are showing no sign of recovery and a few others are continuing to decline. There is a great need for a major increase in awareness of the problems facing the state's natural resources in general and forest resources in particular by both the scientific community and the public, in order to sufficiently protect these vulnerable and valuable resources. Without such a change the prospects for recovery for many of Illinois Endangered and Threatened forest species remains clouded with uncertainty.

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Table 1. Endangered and Threatened animal species of Illinois forests.

Species	Illinois Status
INVERTEBRATES	
Iowa Pleistocene Snail (*Discus macclintocki*)	Endangered**
Cobweb Skipper (*Hesperia metea*)	Threatened
Amphipod (*Stygobromus iowae*)	Endangered
AMPHIBIANS	
Silvery Salamander (*Ambystoma platineum*)	Endangered
Dusky Salamander (*Desmognathus fuscus*)	Endangered
REPTILES	
Great Plains Rat Snake (*Elaphe guttata emoryi*)	Threatened
Western Hognose Snake (*Heterodon nasicus*)	Threatened
Coachwhip Snake (*Masticophis flagellum*)	Threatened
Green Water Snake (*Nerodia cyclopion*)	Threatened
Broad-banded Water Snake (*Nerodia fasciata*)	Endangered
BIRDS	
Great Egret (*Casmerodius albus*)	Endangered
Snowy Egret (*Egretta thula*)	Endangered
Little Blue Heron (*Egretta caerulea*)	Endangered
Black-crowned Night-heron (*Nycticorax nycticorax*)	Endangered
Mississippi Kite (*Ictinia mississippiensis*)	Endangered
Bald Eagle (*Haliaeetus leucocephalus*)	Endangered**
Sharp-shinned Hawk (*Accipiter striatus*)	Endangered
Cooper's Hawk (*Accipiter cooperii*)	Endangered
Red-shouldered Hawk (*Buteo lineatus*)	Endangered
Common Barn-owl (*Tyto alba*)	Endangered
Long-eared Owl (*Asio otus*)	Endangered
Brown Creeper (*Certhia americana*)	Threatened
Bewick's Wren (*Thryomanes bewickii*)	Endangered
Veery (*Catharus fuscescens*)	Threatened
Swainson's Warbler (*Limnothlypis swainsonii*)	Endangered
MAMMALS	
Southeastern Myotis (*Myotis austroriparius*)	Endangered
Gray Bat (*Myotis grisescens*)	Endangered**
Indiana Bat (*Myotis sodalis*)	Endangered**
Rafinesque's Big-eared bat (*Plecotus rafinesquii*)	Endangered
Golden Mouse (*Ochrotomys nuttalli*)	Threatened
Eastern Woodrat (*Neotoma floridana*)	Endangered
River Otter (*Lutra canadensis*)	Endangered
Bobcat (*Lynx rufus*)	Threatened

** Federally Endangered

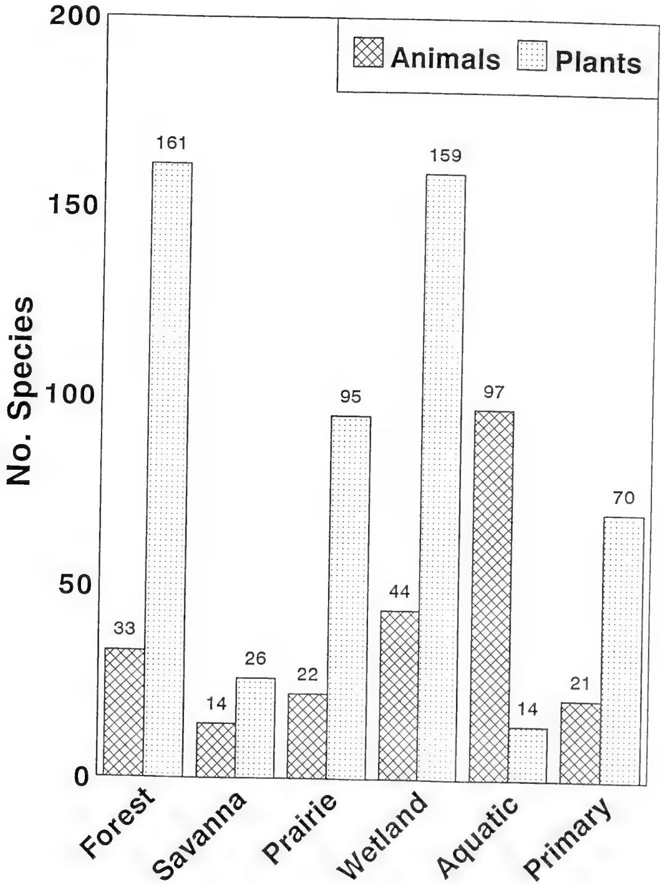

Figure 1. Major habitat associations of Endangered and Threatened plant and animal species in Illinois. Primary habitat is areas with little or no soil development such as dunes, cliffs, rock outcrops, and caves. Other habitat categories are self-explanatory. Note: many species are listed in multiple habitat categories, so the sum total in this figure exceeds the number of state-listed species (500).

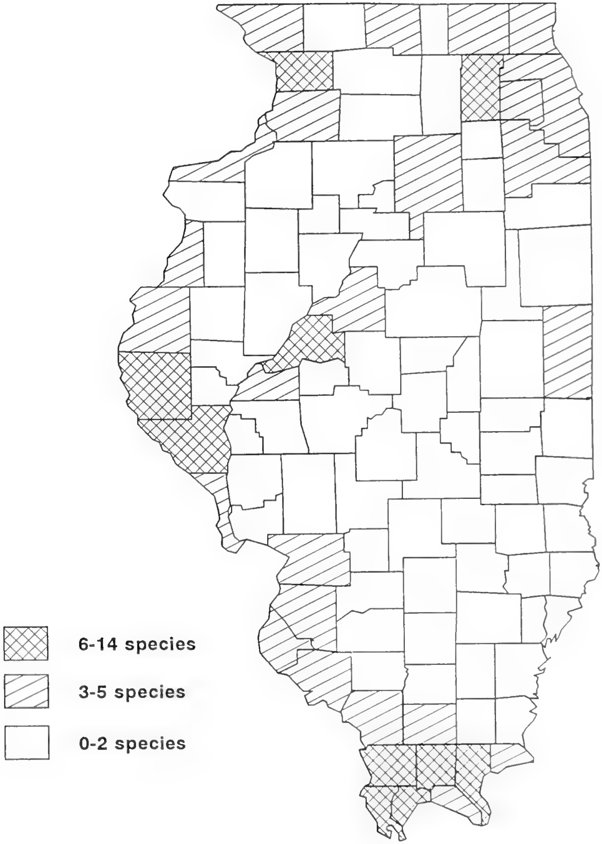

Figure 2. The number of Endangered and Threatened forest animal species known from Illinois counties.

Native Trees for Urban Use: Urbanization of Illinois Forests

George H. Ware

The Morton Arboretum
Lisle, Illinois 60532

Urbanization of stands of native trees is a continuing trend that is disrupting or destroying large areas of forest as functioning ecosystems. Fortunately, some of the forests in urban and suburban areas are being preserved and managed by public agencies such as forest preserve districts, park districts and conservation districts, and there are notable examples of private preservation. The challenge in urbanizing wooded neighborhoods is to prolong the lives of the remaining trees by preserving or simulating natural conditions near the retained trees that have lost their forest. Success in preserving trees is dependent on species, age, and size. The older the tree the less the resilience following construction activities. The larger the tree the larger the spread of the root system and the greater the likelihood that the detrimental impact from soil disturbance will be serious. Urban tree problems often begin underground with damage to the extensive shallow, spreading root systems that are vulnerable to a host of soil-air interface changes associated with construction activities. Protection by fencing of the "drip-line" area under trees is generally effective, but encroachment lists are long: driveways, walks, patios, trenching, compacting, grade-changing, liming, sodding, impounding of runoff, rototilling, *etc*.

The most extensive urbanization in Illinois is occurring in the northeastern region where the forests are dominated by oaks. This discussion concentrates on urbanization of these oak forests but conclusions are thought to be applicable much more widely. The oaks over a period of hundreds of years have had a significant role in producing the soils on which they are found. Oak trees are at home on acid soils, and their fallen leaves help to create and maintain acidic surface layers that differ greatly from the underlying alkaline clayey glacial till from which the regional soils are derived. There are three major oak species in the forests of northeastern Illinois: white oak (*Quercus alba* L.), northern red oak (*Q. rubra* L.), and bur oak (*Q. macrocarpa* Michx.).

Oak forests are highly appealing places to build human dwellings and other kinds of buildings. However, rapid decline of oak trees often follows the invasion and conversion of woodlands with the abrupt transforming changes accompanying construction. There is usually an initial dieback and death of trees that fail to leaf out during the first or second spring following completion of construction. Dieback may become progressively more conspicuous on remaining trees as years pass. Unless resuscitative measures are soon taken, a high proportion of declining trees may ultimately die - sometimes a decade or more later. Because decline usually begins with the death of small branches in the top of an oak, the health of an oak can be assessed by scanning the top of the crown. Both dead branchlets and stunted twigs can be easily spotted, especially at the time of appearance of new foliage in springtime. When dieback of the tips of branches of an oak provides a warning of trouble in the root system, there are two possible resuscitative approaches: increase the root system, or reduce the quantity of foliage in the crown. Because an adverse root environment in the soil is responsible for root deterioration, promoting new rootlet development may be difficult, perhaps requiring several years. On the other hand, removal of branches and branchlets from the crown can immediately reduce the demands on a root system, restoring a favorable root/crown ratio.

A kind of forest especially vulnerable to construction impacts is one that is thickly stocked, with trees in keen competition for space. Close observation usually reveals scattered stunted, declining, and dead trees within the forest even though the forest appears to be in good condition. Closely spaced trees have long trunks and small crowns. The sheltering and the microclimate tempering of the closed canopy maintain a relative evenness of levels of humidity, soil moisture, and temperature, making

possible the existence of large trees in limited spaces with limited root systems. But abrupt removal of numerous trees drastically changes the microclimate, permitting environmental fluctuations and adversities that were not present in the intact forest system. Even without additional man-inflicted insults, the stage is set for detrimental episodes of excessive soil drying and damaging high levels of transpiration. The root systems are no longer sufficient to serve properly the same crowns that were in equilibrium with the root systems before the forest was disturbed. Thus, additional modifications of the environment, especially soil changes, often have drastic negative effects on the remaining trees.

Oaks in forests tend to have dual root systems: a highly proliferative fine-root system in the upper 15 cm of porous organic soil and a less freely branching system at a depth of 30 to 80 cm. A healthy fine-root system is a very effective absorber of water, mineral, nutrients, and oxygen. But it is also very easily destroyed or impaired by activities changing the nature of the soil-air interface. Restoration of a fine-root system can be facilitated by the application of mulches. Mulches not only supply organic matter but also suppress existing grass, which soon decomposes. The use of mulches around stressed oaks appears to have a favorable effect in arresting decline. Additionally, ground cover may be planted in the mulch without producing root competition nearly so severe as that of sod. Interception and incorporation of falling leaves by the ground cover further promote the build-up of organic matter and the simulation of the surface soil layer of nature woodland. Ideally, a layer of well-decomposed leaves should be laid down first with coarser wood chips or bark chips forming a top layer.

An example of a long-time change of the soil environment following urbanization involves chlorosis (foliage yellowing). The widespread prevalence of chlorosis in older wooded neighborhoods is directly related to changes associated with decades of separation of the trees from their forests. Soils of the lawns surrounding the trees have been slowly alkalinized by the yearly removal of leaves which in past times (in the forest) had been recycled as acidifiers of the forest soil. Chlorosis is especially evident in white oak during hot and dry summers. Application of organic mulches (leaf compost, wood chips, bark nuggets, *etc.*) initiates acidification processes but significant reversal of changes in soil pH may require years. There is much evidence that runoff from paved surfaces, both concrete and blacktop, tends to alkalinize soils. Indeed acid rain may accelerate the dissolution of limey surfaces, further alkalinizing nearby soils.

Oaks provide for us some constructive examples of the necessity for understanding ecological attributes and requirements that are closely linked to natural soil and tree-growth processes measured on a time-scale of decades or more. Oaks are a near-irreplaceable legacy that we can utilize and maintain only if we live and work with them on their terms.

Some of the recommendations for saving oak trees in the path of detrimental construction activity are:

1. Retain natural conditions of the forest floor wherever possible and fence off an area under the drip-line as a "no-violation" zone.

2. Retain groups of trees as "mini-forests" so that detrimental encroachment is more difficult and preservation of a larger area of soil-air interface is possible.

3. Preserve understory trees and saplings wherever possible. Released saplings usually show surprisingly fast growth following removal of overtopping crowns. Young trees almost always have a greater chance of survival following soil disturbance than do old trees.

4. Utilize future driveways for construction traffic from the beginning of construction activity so that the extent of compaction by vehicular traffic will be minimized.

5. Selectively remove branches from the interior of the crown in anticipation of loss of roots or impaired root efficiency.

6. Utilize augering to avoid the damage caused by trenching or installation of utilities.

7. Concentrate utility corridors in ways to avoid encroachment on oaks and other trees.

8. Cut roots cleanly and avoid tearing should root-cutting be unavoidable.

9. Do not cut or add soil near oak trees. The vital surficial fine-root system can be suffocated by a mere 5 to 8 cm of fill material. Similarly, cutting to a depth of 15 cm may remove much of the fine-root system.

10. Follow the rationale that a desirable procedure is to set a home into dedicated space (an "envelope") where necessary trees have been removed, but all of the remaining trees and their soil environment remain intact.

Effects of Simulated Stratospheric Ozone Depletion on Seedling Growth of Several Species of Hardwood Trees

Evan H. DeLucia, Shawna L. Naidu, and Jeannie Chen

Department of Plant Biology
University of Illinois
Urbana, Illinois 61801

ABSTRACT

The potential effects of stratospheric ozone depletion on the growth of six species of deciduous hardwood tree seedlings were examined under artificial lighting in a greenhouse. Two shade-tolerant (*Amelanchier arborea* and *Cercis canadensis*) and four shade-intolerant species (*Betula papyrifera*, *Morus alba*, *Nyssa sylvatica*, and *Robinia pseudoacacia*) were examined. Ultraviolet-B radiation (UVB, 280-320 nm), simulating a 40% depletion in stratospheric ozone, was administered to the treatment plants and the control plants received no UVB radiation. Four of the six species were unaffected by the treatment. However, total biomass, plant height, and leaf area were significantly reduced by the UVB treatment for *Cercis canadensis* (shade tolerant) and *Morus alba* (shade intolerant). There was no difference between the response of shade-tolerant versus intolerant species to UVB radiation for the limited number of species examined in this study. The artificial lights and filters used to generate the UVB exposure also altered incident doses of UVA radiation (320-400 nm). These wavelengths induce a number of UV protection and damage repair processes. Extrapolating the potential responses of the two UV-sensitive species to the natural setting is limited by our inability to administer realistic UVB enhancements without simultaneously altering ultraviolet-A radiation (UVA, 320-400 nm). That growth inhibition was caused by relatively short exposures to UVB radiation, however, leads us to predict that *Cercis canadensis* and *Morus alba* will be susceptible to future reductions in stratospheric ozone.

INTRODUCTION

Ultraviolet-B radiation (UVB, 280-320 nm) is potentially damaging to plants. It is absorbed by a wide array of macromolecules, including proteins, lipid membranes, and DNA, and can disrupt many physiological processes (Caldwell *et al.* 1989, Tevini and Teramura 1989). Extraterrestrial UVB radiation impacting the atmosphere is approximately 22 W m-2, although only 5 W m-2 actually reaches the surface (values are for 1977; Hader and Tevini 1987). Thus, 77% of incident UVB radiation is absorbed by the atmosphere. The primary absorber of this radiation is stratospheric ozone. As a result of the anthropogenic release of chlorofluorocarbons (CFCs) into the atmosphere, this protective layer is being destroyed at an alarming rate; there has been an approximately 11% decrease in ozone concentration at mid-northern latitudes in the past decade (Kerr 1988, 1991). Because these compounds persist in the atmosphere for a long time, in excess of 100 years, efforts to reduce or eliminate their release will not mitigate rates of ozone depletion within the foreseeable future.

Many aspects of plant function are inhibited or damaged by UVB radiation-- photosynthesis is particularly sensitive (Sisson and Caldwell 1977, Bornman 1989). Alteration of physiological functions is manifest at higher levels of biological organization, and UVB is known to cause reductions in height growth and biomass accumulation, as well as interfering with pollination and flowering (Tevini and Teramura 1989; and references therein). These perturbations in plant function potentially alter ecological interactions, such as competition, among species (Barnes *et al.* 1988).

Susceptibility of terrestrial plants to damage caused by enhanced levels of UVB radiation varies widely among species and even between different varieties or populations within a species. For example, exposure to UVB levels that simulated a 40% decrease in the ozone column caused a significant decrease in biomass for the Essex variety of soybean but an increase for the Forest variety (Teramura and Sullivan 1987). Similar variation in susceptibility has been observed for native plants distributed along natural latitudinal or elevational UVB gradients (Robberecht *et al.* 1980, Caldwell *et al.* 1982, Sullivan *et al.* 1992, Ziska *et al.* 1992). Much of this variation in susceptibility is caused by differential ability to screen UVB radiation from entering photosynthetic tissue by the production of UV-absorbing pigments in the vacuole of epidermal cells or in the leaf cuticle (Caldwell *et al.* 1983b, Day *et al.* 1992).

Relatively few studies have examined the potential impact of enhanced levels of UVB radiation on native plants, particularly trees. Because forest ecosystems contribute roughly 50% to global net primary productivity (Leith and Whittaker 1975), damage to trees by UVB may have far-reaching consequences for global carbon cycling. In a study of Pinaceae that included representatives from three genera, Sullivan and Teramura (1989) found that exposure to enhanced levels of UVB radiation caused a 30 to 40% reduction in biomass for some members of the genus *Pinus*. *Pinus taeda* was the most susceptible species. In contrast, representatives of *Abies* and *Picea* were unaffected. The objective of this study was to examine the effect of a simulated 40% decrease in stratospheric ozone on seedling growth and biomass allocation of several deciduous hardwood trees species. Two shade-tolerant and four shade-intolerant species were included in this initial study. These two types of trees were included to determine if susceptibility to UVB damage is correlated with genetic potential to tolerate shade. We predicted that adaptations to low light, such as high leaf area/leaf mass ratio and a monolayer leaf display may increase absorbance of UVB radiation and increase the degree of damage.

MATERIALS AND METHODS

Six species of hardwood trees were grown from seed (F.W. Schumacher Co., Inc., Sandwich, MA) in a greenhouse. They included two shade-tolerant species (*Amelanchier arborea* and *Cercis canadensis*) and four shade-intolerant species (*Betula papyrifera*, *Morus alba*, *Nyssa sylvatica* and *Robinia pseudoacacia*). Other features of the ecology of these species are presented in Table 1. Where necessary seeds were stratified or scarified (Schopmeyer 1974). Seedlings were germinated in flats containing vermiculite and grown in 1.5-L pots for 11-28 days prior to initiating the treatment. The growth medium was a sand:soil:calcite clay mixture (1:1:1, v/v) and plants were watered and fertilized as needed to maintain maximum growth rates. Thirty seedlings were selected for uniformity and randomly divided into a treatment and a control group. Because of limited space under the UV lamps, experiments were conducted with 2 or 3 species simultaneously, in consecutive experiments. Individual species were grown under the experimental conditions for various lengths of time. This was done to minimize the potential for pot binding for the more rapidly growing species. Duration under the treatments varied from 45 to 112 days (Table 1).

A "plus UVB" and "minus UVB" exposure was administered to seedlings in a greenhouse. Ultraviolet-B radiation was supplied by filtered fluorescent UV lamps (UVB-313, Q-Panel Co., Cleveland, OH). The lamps were mounted (20-cm spacing) in two adjustable racks above a 1.8 x 4.3-m greenhouse bench. Visible light was supplemented with 4 HID mixed-vapor lamps mounted above each rack of UV lamps. The UV lamps were wrapped with either pre-solarized cellulose acetate (.005-mm thick) or Mylar (.005-mm thick). The cellulose acetate film absorbed irradiance below ca. 280-nm wavelength (UV-C portion of the spectrum) and was used to provide the +UVB treatment. The Mylar film absorbed irradiance below ca. 313-nm and provided the -UVB control. The dose was maintained as the filters aged by varying the height of the lamps relative to the tops of the plants.

Spectral irradiance under the lamps was measured with a portable UV/VIS spectroradiometer (OL 752, Optronics Lab., Inc., Orlando, FL). The spectroradiometer employs a double monochrometer with dual holographic gratings and was configured with 0.25-mm slits, that produced a nominal half-band width of 1.5 nm. The input optic was an

integrating sphere with a flat quartz window. Prior to measurements the spectroradiometer was calibrated with a NIST-traceable 200-W tungsten-halogen lamp, and wavelength alignment was checked against the mercury-emission lines from a fluorescent bulb. The dose under the lamps was checked daily with a broad-band radiometer (SED240, International Light, Inc., Newburyport, MA; DeLucia *et al.* 1991), that was calibrated against the spectroradiometer using the generalized plant-damage action spectrum weighted to 300 nm (Caldwell *et al.* 1983a).

The treatment plants received 19.1 KJ of biologically effective UVB radiation daily (*i.e.* weighted by the plant action spectrum). This simulates a 40% depletion of stratospheric ozone for Beltsville, Maryland on the summer solstice. The dose was administered for 6-10 hours around noon to avoid providing high UVB and low visible irradiance. The HID lamps extended the photoperiod to 14 hours; and the maximum and minimum photosynthetic photon flux density provided with the supplemental HID lamps were 1600 and 400 mmol m-2 s-1, respectively. The mean day and nighttime air temperatures were 25o and 20oC, respectively. Humidity in the greenhouse was uncontrolled and varied from ca. 20 to 60%.

At the end of the treatment period plants were harvested, separated into components, dried at 70oC (48 h) and weighed. Leaf area was measured with a video area meter (Delta-T, Decagon Devises, Inc., Pullman, WA). Following a test for homogeneity of variances, mean values were compared using a t-test (STATISTIX 3.0, Analytical Software, St. Paul, MN).

RESULTS AND DISCUSSION

The response of these 6 hardwood tree species to enhanced levels of UVB radiation was highly variable, and there was no difference in the response of shade-tolerant versus intolerant species. Total biomass of *Amelanchier arborea*, *Betula papyrifera*, *Nyssa sylvatica*, and *Robinia pseudoacacia* were unaffected by the treatment (Table 2). Of these four species, *A. arborea* is shade tolerant. Total biomass of *Cercis canadensis* and *Morus alba* were reduced by 24 and 8%, respectively, by the UVB treatment ($p<.05$, Table 2). The former species matures into a relatively small tree and is characterized as tolerant of shade in the seedling stages; whereas the later, a naturalized Asian exotic, typically grows in open disturbed areas and is considered intolerant of shade. Shade-grown plants are more susceptible to UVB damage than sun-grown plants (Teramura *et al.* 1980, Chen and Bornman 1990). This may be attributable in part to the lack of appreciable accumulation of protective pigments, the production of which are stimulated by exposure to high levels of UVB and visible irradiance (Caldwell *et al.* 1983b, Tevini *et al.* 1989). Our results indicate that this difference in susceptibility does not hold for species genetically characterized as having differences in shade tolerance, although the limited number of species examined in this study precludes a definitive conclusion.

For the two UVB-sensitive species the components of total biomass (root biomass, shoot biomass, *etc.*) were inhibited proportionately. Although statistically significant differences were not observed for all components, shoot, root, stem, and leaf biomass were all reduced by the UVB treatment (Table 2). Enhanced UVB radiation did not, therefore, drive major biomass allocation shifts as indicated by the lack of differences in root/shoot ratio between the treatment and control plants.

For *C. canadensis*, *M. alba*, and *A. arborea*, the UVB treatment significantly altered aspects of canopy architecture. Total leaf area was reduced for *C. canadensis* and *M. alba* (Table 3). There was no effect on the number of leaves for these species, therefore the area per leaf was 9-25% lower in the treatment plants. Total leaf area of *A. arborea* was unaffected, but an increase in the number of leaves also caused a reduction in area per leaf under the UVB treatment. The reduction in photosynthetic leaf area for *C. canadensis* and *M. alba* may have contributed to lower total biomass accumulation for these species.

In addition to reduced total biomass, the UVB treatment also caused a reduction in height for the two sensitive species. Seedling height was 10% lower for *M. alba* and 14% lower for *C. canadensis* grown under the UVB treatment (Table 3). For *M. alba* the reduction in height was attributed to fewer and shorter internodes, while the treatment caused a decrease internode length only for *C. canadensis*.

Height growth is controlled by several environmental variables including incident light. The phytochrome system is involved in responding to alterations in the visible light environment, and results from recent studies suggest that UVB interferes with phytochrome interconversion (Lercari *et al.* 1989, Fernbach and Mohr 1990) and, possibly, hormone production (Giese 1964). Reduced height growth for the two sensitive species in this study could alter their competitive ability in a natural setting (Barnes *et al.* 1988).

Although this experiment was designed to examine the effects of differential UVB radiation on the growth of hardwood seedlings, the experimental treatment was confounded by different quantities of UVA (320-400 nm wavelength) produced by the the CA-filtered and Mylar-filtered lamps (Figure 1). Both treatment and control lamps enhanced UVA relative to the HID lamps and sunlight alone; and the +UVB lamps also enhanced UVA relative to the control (-UVB). Although damaging to phytoplankton (Cullen *et al.* 1992), the extent to which short wavelength UVA radiation is damaging to plants is not known. However, longer wavelength UVA irradiances, extending into the blue portion of the spectrum, are important for inducing molecular repair processes (Pang and Hays 1991) and the production of protective pigments (Tevini *et al.* 1991).

Plants exposed to UVB radiation in greenhouses, particularly if they have had no previous exposure, tend to be more susceptible to this damaging radiation than plants exposed to natural sunlight regimes (Caldwell *et al.* 1989, Tevini and Teramura 1989). Therefore, our data may provide an overestimate of the potential impact of stratospheric ozone reduction on the growth of these species. It is, however, striking that inhibition of the two sensitive species was apparent after a relatively short exposure. The magnitude of inhibition is comparable to that observed for other sensitive species exposed for considerably longer time. Thus, we predict that *C. canadensis* and *M. alba* will be sensitive to enhanced UVB under field conditions.

As is the case for other growth forms, the response of hardwood tree seedlings to enhanced UVB radiation was highly variable. The mechanisms underlying resistance to UV damage are not clearly understood; however, differential ability to produce soluble (Caldwell *et al.* 1983b, Tevini *et al.* 1991) or insoluble (Day *et al.* 1992, DeLucia *et al.* 1992) UVB-screening pigments may account for some of these differences in susceptibility. In addition to the potential for stratospheric ozone depletion to reduce forest productivity, the differential sensitivity of species suggests that this additional anthropogenic assault on native ecosystems may lead to changes in species composition.

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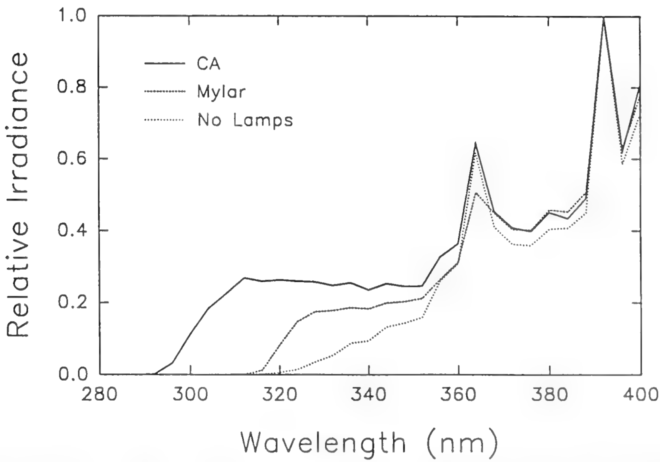

Figure 1. The relative spectral irradiance under the +UVB treatment (.005 mm cellulose acetate film, CA) and the -UVB control (.005 mm Mylar film). The "No Lamps" scan includes sunlight filtered through the greenhouse and light from the HID lamps. Curves were normalized 390 nm.

Table 1. Ecological characteristics and growth form. Data were derived from Burns and Honkala (1990). Days after planting (DAP) designates when plants were moved into the treatment, and DURATION designates the time in the UVB treatment.

Species	Family	Common Name	Habitat	Shade Tolerance	DAP	Duration of Treatment
Amelanchier arborea (Michx. f.) Fern.	Rosaceae	Shadbush	wooded slopes cliff edges	tolerant	57	86
Betula papyrifera Marsh.	Betulaceae	Paper Birch	riparian, wooded slopes	intolerant	63	81
Cercis canadensis L.	Caesalpiniaceae	Redbud	rich woods	tolerant	46	73
Morus alba L.	Moraceae	White Mulberry	roadside	intolerant	53	101
Nyssa sylvatica Marsh.	Nyssaceae	Sour Gum	dry wooded slopes	intolerant	47	112
Robinia pseudoacacia L.	Fabaceae	Black Locust	woodlands, roadsides	intolerant (very)	34	45

Table 2. Biomass (g) and root/shoot ratio of tree seedlings exposed to UVB radiation. The root/shoot ratio (g/g) is designated by RT/ST. Values are means of 14-15 plants, and values designated with an asterisk are different at $P<.05$.

Species	UV-B	Shoot	Root	Stem	Leaf	Total	RT/ST
Amelanchier	+	32.27	9.74	14.49	17.77	42.01	0.298
arborea (Michx. f.) Fern.	-	30.25	8.12	14.09	16.16	38.36	0.267
Betula papyrifera Marsh.	+	27.79	12.62	11.03	16.76	40.41	0.458
	-	29.05	13.25	11.01	18.04	42.31	0.458
Cercis canadensis L.	+	15.40 *	4.14 *	6.21	9.19	19.55 *	0.265
	-	20.04	5.83	7.59	12.45	25.87	0.283
Morus alba L.	+	52.92 *	23.55	22.36 *	30.56 *	76.47 *	0.450
	-	59.21	27.00	25.13	34.08	86.20	0.455
Nyssa sylvatica Marsh.	+	10.08	3.03	3.47	6.61	13.11	0.311
	-	9.35	3.02	3.11	6.23	12.36	0.323
Robinia pseudoacacia L.	+	32.68	8.14 *	13.09	18.57	40.75	0.254
	-	29.94	6.86	12.00	17.94	36.70	0.227

Table 3. Growth characteristics of tree seedlings exposed to UVB radiation. Lengths (*e.g.* Height and Node Length) are expressed in cm, and area (Leaf Area) is in m2. The ratio of leaf area to total biomass is indicated by LAR (m2/g), and the ratio of leaf mass to leaf area is indicated by SLM (g/m2). Values are means of 14-15 plants, and values designated with an asterisk are different at P<.05.

Species	UV-B	Height	Area	LAR	SLM	#Leaves	#Nodes	Node Length
Amelanchier	+	95.50	0.241	59.72	0.0073	76 *	40	2.23
arborea (Michx. f.) Fern.	-	101.30	0.225	59.95	0.0072	63	44	2.15
Betula papyrifera Marsh.	+	80.79	0.660	161.70	0.0026	88	28	2.92
	-	76.25	0.680	162.00	0.0027	94	27	2.84
Cercis canadensis L.	+	108.60 *	0.150 *	81.59	0.0061	23	23 *	4.51 *
	-	125.90	0.210	82.37	0.0059	52	25	4.86
Morus alba L.	+	82.72	1.200 *	154.60	0.0039	366	44	1.81 *
	-	91.58	1.300	161.60	0.0025	369	46	1.98
Nyssa sylvatica Marsh.	+	46.54	0.160	124.60	0.0042	276	31	1.43
	-	40.21	0.146	123.10	0.0043	239	27	1.42
Robinia pseudoacacia L.	+	109.20	0.470	118.00	0.0040	90	31	3.27
	-	109.30	0.460	126.90	0.0039	94	30	3.38

Floristic Changes After Five Growing Seasons in Burned and Unburned Woodland

Gerould Wilhelm and Linda Masters

The Morton Arboretum
Lisle, Illinois 60532

ABSTRACT

Five years of transect data were taken in a burned and unburned woodland during the spring, summer, and fall of each year from 1988 to 1992. The data indicate that consistent and directional changes occurred in the burned tract, while the floristics of the unburned tract remained virtually unchanged. Native species diversity increased each year in the burned tract, as did the floristic quality index and the number of conservative species. All indices were relatively stable in the unburned tract, except for a consistent and marked decrease in floristic quality as the season progressed each year. In the burned tract, the total number of species in bloom in any given week increased over the five-year period, but there was a greater increase among those species which bloom in summer and fall. In the unburned tract, there was no demonstrable change in the preponderance of flowering species from season to season. In the burned tract, woody species such as *Parthenocissus quinquefolia* decreased in relative importance, while late-season forbs such as *Helianthus strumosus* and *Solidago ulmifolia* increased. In the unburned tract, there were fewer species overall than in the burned tract, and the top three remained constant in relative importance. The dominance of *Parthenocissus quinquefolia* was unchanged in the unburned tract, with an overall relative importance of 25% each year. Light-meter readings showed that there was about 2.5 times as much light reaching the ground during the middle of the growing season in the burned tract than in the unburned tract.

INTRODUCTION

In the spring of 1988, monitoring was begun on two adjacent tracts of woodland, at the Morton Arboretum in Du Page County, Illinois. The woodland, dominated originally by Bur and White Oak (Ewing 1840), had been heavily grazed during the early part of the century, then kept mechanically cleared of underbrush until the middle 1960's, at which time all active management of the tract ceased. The woods is located on the west side of a morainic pothole marsh, known at the Arboretum as the Bur Reed Marsh. The elevation of the woodland rises slightly, but perceptibly, as one moves west from the marsh. An old but well-maintained woodchip path divides the woods north and south. By the fall of 1984, the woods on the east side of the path had become a dense, impenetrable tangle of Eurasian shrubs and fallen trees. The shade was so intense that little ground cover was apparent except right along the trail where light was still available; there was an even thicker edge of shrubbery along the border between the woods and the marsh. The western side of the trail lacked much of the tangle of fallen timber, but was otherwise quite similar in its inhabitancy by Eurasian shrubs.

During the spring of 1985, a fire was set along the east edge of the trail and allowed to backburn into the woods. Another fire was set within the matrix of *Carex lacustris* in the marsh and allowed to enter the shrub thicket from the west. Controlled burning was administered in a similar manner during the early spring months of 1986, 1987, and 1988, and has continued to date. Fire was not allowed to enter the woods to the west of the path. By the spring of 1988, monitoring of the vegetation began in the burned woods on the east side of the trail and in the unburned woods west of the trail.

METHODS

During the spring of 1988, an 80-meter line transect

were placed at random intervals along the transect. A transect of similar dimensions was laid out through the woodland tract on the west side of the trail, beginning at a small American Elm opposite the above-mentioned Bur Oak, and trended north-northeast, ending usually 2-4 quadrats north of another large Bur Oak. The transects were repeated in summer and fall of that year, and 3 times yearly since.

Within each quadrat, an inventory of the vascular plant species was made and a Braun-Blanquet (1932) cover-abundance coefficient (1-5) assigned to each species. With the exception of *Rubus* species, which arch over the quadrat, only species with stems originating within the quadrat were included in the inventory. Cotyledons, seedlings, and juveniles were included when identity was certain. The same taxonomist conducted all of the sampling identifications in the field, so a measure of consistency, if not accuracy, was ensured. Nomenclature follows Swink and Wilhelm (1979).

The data were analyzed in two ways. We looked at quadrat averages and at the transect as a whole. We also combined the three seasonal transects into one to arrive at the yearly totals. For each quadrat, coefficients of conservatism (Swink & Wilhelm 1979 and Wilhelm & Ladd 1988) were assigned to each species present. The mean coefficient was determined and a floristic quality index calculated as described by Wilhelm (1991), resulting in a quadrat coefficient of conservatism and a quadrat quality index. Average quadrat coefficients and quadrat indices were calculated, both for each season and for the year as a whole.

Each year the mean coefficient of conservatism and floristic quality index were calculated for all species which appeared in the transects over the three seasons. From this aggregate transect data, the number of species with coefficients of conservatism ranging from 4-10 were totaled. Also, from the combined transects, the number of species in bloom in any given week were totaled. For example, a species known locally to bloom from 1 May (week 9) to 1 June (week 14) was counted once for each of the blooming weeks 9-14.

Frequency values and cover values were relativized, and relative importance values were calculated by summing the relative frequency and cover values for each species and dividing by 2. Light availability was measured along each transect, on a cloudless day at noon, 23 July 1990, using a Sekonic Studio Deluxe (model #L-398) light meter. Measurements were taken wearing drab clothing and with the meter held about 3 dm above the ground.

RESULTS

By the spring of 1988, the woods on the east side of the trail had been burned four times. While we did not have pre-burn data, it is apparent from the graph in Figure 1 that the number of native species per quadrat has increased yearly in the burned tract since 1988, while the number of species has remained virtually constant in the unburned tract. A one-way ANOVA showed significant differences among years ($F = 12.51$, $df = 4, 266$, $P < 0.001$) for the burned tract, while there was no significant difference in the unburned tract ($F = 12.51$, $df = 4, 262$, $P = 0.5322$). For the burned tract, a Bonferroni Post Hoc analysis showed no statistical differences between 1988 and 1989 or among the years 1990-1992, but both 1988 and 1989 differed from each of the years 1990-1992.

To examine species richness trends further, linear regressions were conducted for the total number of native species and the total number of conservative species for each of the years 1988-1992. For the burned tract, a strong positive trend of increasing total richness *versus* year ($y = 77.659 + 4.7x$, $r^2 = .6776$, $p = 0.087$), and a significant positive trend in conservative species richness *versus* year ($y = -170.4 + 2.2x$, $r^2 = 0.91$, $p = 0.012$). No trend was found for the unburned tract for either total species richness or conservative species (Figure 2).

Quadrat data showed that for both the burned and unburned tract, the mean coefficient of conservatism has experienced no discernible change over the five years (Figure 3). There also is no measurable change in the transect as a whole, there being an offsetting enrichment by both conservative and non-conservative species (Figure 4). Floristic quality indices have risen each year in the burned tract, both at the quadrat level (Figure 5) and for the transect as a whole (Figure 6). Little or no change has been indicated in the unburned tract.

There were marked differences in the data from season to season in the burned and unburned tracts. Figure 7 shows that the seasonal floristic quality has nearly equilibrated in the burned tract, while in the unburned tract the quality dropped off steadily from spring, through summer to fall (Figure 8). Figure 9 shows that in the unburned tract, the species present have blooming ranges prevailing in the spring, with little change from 1988 to 1992. The burned tract shows a similar peak in spring, but an increase over the five years in the total number of species in bloom in any given week, and with a marked increase in the late summer and fall weeks.

Table 1 shows changes in the relative importance values of the species in the top 50% over the five-year period. Note that in both the burned and unburned tracts, the weed, *Alliaria officinalis,* is an important and persistent element, but controlled annual burns do not appear to have caused its relative importance to have increased. Notable increases in the importance of moderately conservative, fall-blooming species such as *Helianthus strumosus* and *Solidago ulmifolia* are occurring in the burned tract, while little discernable, consistent change has occurred in the unburned tract. There are more species making up the top 50% of important species in the burned tract, with *Parthenocissus quinquefolia* remaining preemptively important and virtually unchanged in the unburned tract.

Light data taken along the two transects showed that in July, 1990, the mean light availability in the unburned tract was 480 footcandles, with a median availability of 320. In the burned tract, light availability was 1280 footcandles on the average, with a median value of 575. In full sun during the same period there were about 10000 footcandles.

DISCUSSION

If one were to regard regular increases in native biodiversity to be a positive trend in remnant plant communities, one could conclude that annual controlled burns may result in system improvement. The study has not shown, however, that over this five-year period fire suppression in a degraded woodland remnant has been measurably deleterious. In the burned tract, average quadrat quality has yet to show a change. We speculate that overall increases in the number of conservative species has not yet resulted in the degree of coalescence necessary to offset increases in non-conservative species which also proliferate when a system is opened to increased light levels. Swink & Wilhelm (1979) gave only 10% of the native flora, about 160 species, conservatism values from 0-3, so such species are far outnumbered potentially by more conservative species. Since the number of conservative species is increasing in the burned tract, it may be hypothesized that, if they continue to burgeon, their presence will be reflected in the data by increases in quadrat coefficients of conservatism.

Many studies, still in progress, as well as this one, have shown that the mean coefficient of conservatism can be a difficult datum in which to register change in remnant areas over short periods of time such as 5 years. In our experience in the Chicago region, natural areas usually have mean coefficients of conservatism ranging from 5-7 at the quadrat level, so it is clear that the Bur Reed Woods, with values ranging from 2.3-2.7, has a long way to go before it can be said to have reached natural area quality. Actually, the likelihood that such conservatism still exists anywhere within the wooded remnants of the Morton Arboretum is remote (Wilhelm 1991). It is probable that the most one could expect would be values stabilizing in the 3.3-3.7 range. Additional increases probably will require the introduction of chronically absent or locally extirpated conservative species. For the time being, it would seem that the benefits of controlled burning are still being realized. Continued monitoring will identify the point at which controlled burn management no longer mediates system improvement.

It is probable that the seasonal variations noted in the burned and unburned tracts are related to available light levels. In the unburned tracts, the floristic quality indices are similar to the burned tract in spring, when the leaves of the shrubs and canopy trees are absent or only just unfolding (Hutchison & Matt 1977). As the growing season progresses, the amount of available light is diminished more completely in the unburned tract. While the controlled burns have not had much effect on canopy trees, the coverage of the understory and shrub layer has been much reduced, allowing more light availability throughout the growing season.

While the controlled burns have not had much effect on canopy trees, the coverage of the understory and shrub layer has been much reduced, allowing more light availability throughout the growing season. The somewhat larger drops in floristic quality indices shown in the fall seasons of 1988 and 1991 for both the burned and unburned tracts might be related to summer drought periods during those years.

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Table 1. Comparisons of relative importance values from 1988 to 1992 in burned and unburned tracts of woodland at the Morton Arboretum. Values shown without brackets are in the top 50% of the relative values. Values shown in brackets are species which have appeared in one year or more years in the top 50%, but not in the year shown above. Non-native species are designated with an asterisk.

BURNED					
	1988	1989	1990	1991	1992
Alliaria officinalis *	13.0	8.7	12.4	8.8	9.4
Sanicula gregaria	8.4	10.1	5.0	5.2	7.9
Polygonatum canaliculatum	8.0	4.7	4.7	7.0	6.8
Helianthus strumosus	[0.7]	[1.4]	[1.7]	5.0	6.1
Eupatorium rugosum	6.8	6.4	8.0	5.7	6.1
Circaea quadrisulcata v. *canadensis*	7.3	7.1	8.0	6.9	5.9
Solidago ulmifolia	[0.6]	[0.3]	[1.4]	[2.8]	4.1
Smilacina racemosa	6.2	5.3	4.5	4.6	3.7
Smilax ecirrhata	[5.6]	[3.0]	4.0	4.7	[3.6]
Rubus occidentalis	[1.7]	[2.3]	[3.2]	4.5	[3.6]
Menispermum canadense	6.3	[4.3]	4.3	[3.3]	[1.8]
Parthenocissus quinquefolia	[4.4]	8.6	[2.0]	[2.1]	[1.0]
UNBURNED					
Parthenocissus quinquefolia	24.9	24.7	24.6	25.9	23.4
Alliaria officinalis *	18.2	11.6	11.4	11.9	14.7
Smilacina racemosa	8.0	7.4	6.8	6.6	8.1
Arisaema atrorubens	[0.8]	[3.1]	[3.1]	[1.9]	4.1
Geranium maculatum	----	[3.7]	[2.5]	5.2	[3.1]
Viburnum recognitum *	[2.9]	5.4	5.3	[2.4]	[2.6]
Circaea quadrisulcata v. *canadensis*	[3.6]	[4.0]	3.9	[4.3]	[1.8]

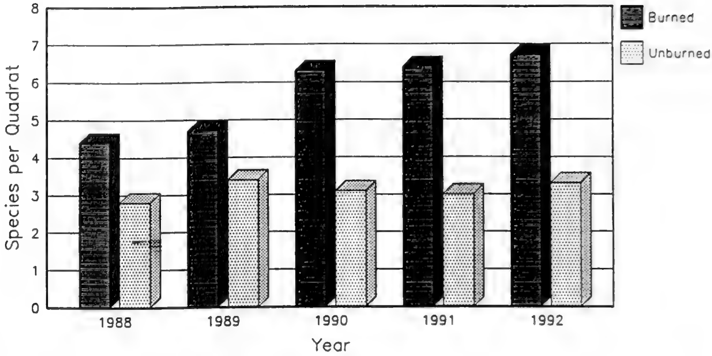

Figure 1. Number of native species per quadrat from 1988-1992, based upon averages of spring, summer, and fall in burned and unburned tracts.

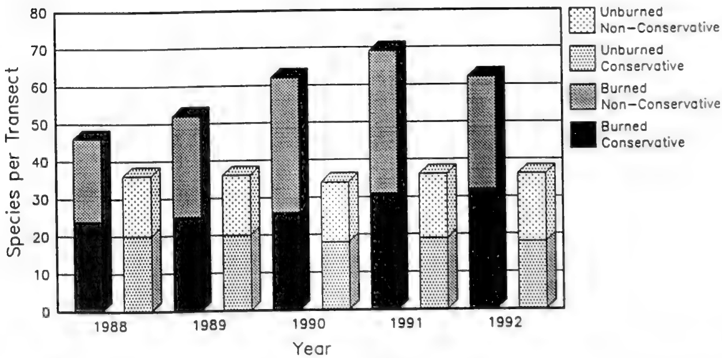

Figure 2. Total number of species per transect, showing the ratio between the number of conservative *versus* non-conservative species in burned and unburned tracts over five years.

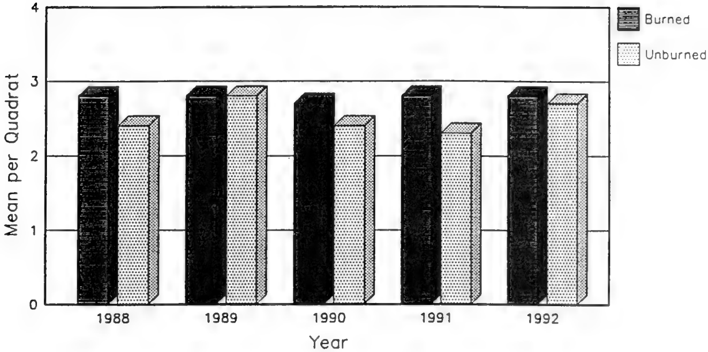

Figure 3. Mean coefficient of conservatism per quadrat from 1988-1992, based upon averages of spring, summer, and fall in burned and unburned tracts.

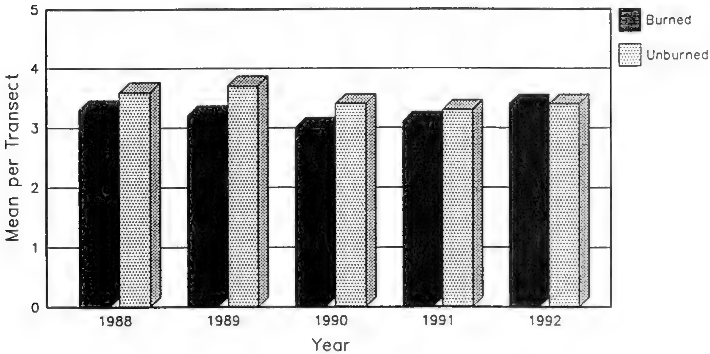

Figure 4. Mean coefficient of conservatism per transect from 1988-1992, based upon averages of spring, summer, and fall in burned and unburned tracts.

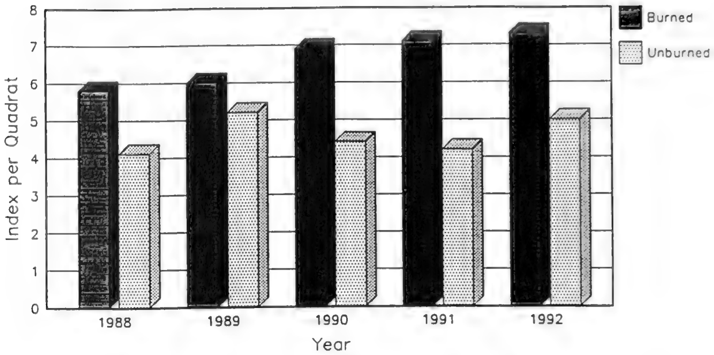

Figure 5. Floristic quality index per quadrat from 1988-1992, based upon averages of spring, summer, and fall in burned and unburned tracts.

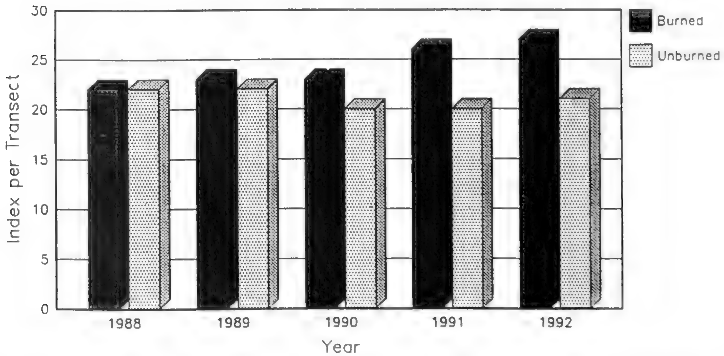

Figure 6. Floristic quality index per transect from 1988-1992, based upon averages of spring, summer, and fall in burned and unburned tracts.

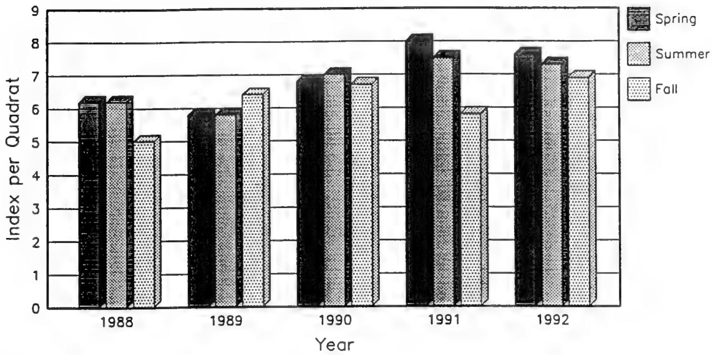

Figure 7. Floristic quality index per seasonal transect from 1988-1992 in the burned tract.

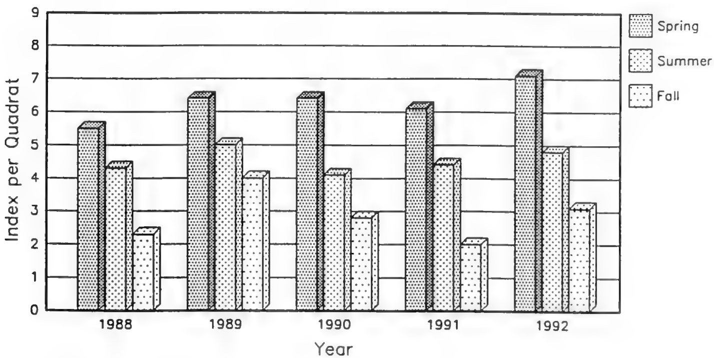

Figure 8. Floristic quality index per seasonal transect from 1988-1992 in the unburned tract.

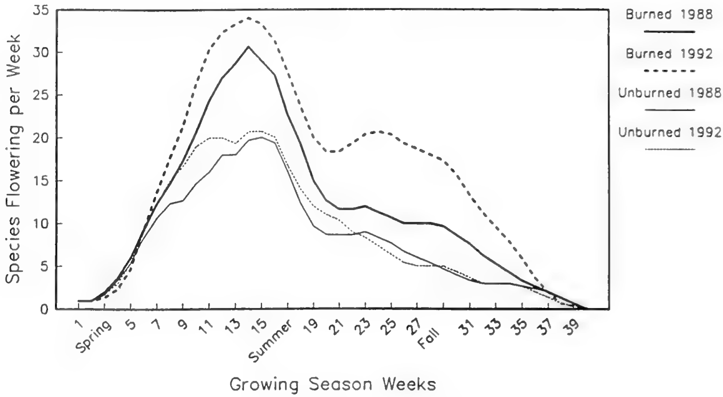

Figure 9. Changes in the number of species in bloom during any given week of the growing season, 1988 *versus* 1992.

Abstracts of Other Papers Presented

The Forest Stewardship Program in Illinois

Gary L. Rolfe and Stephanie S. Brown, Department of Forestry, University of Illinois

The Forest Stewardship Program offers technical assistance to qualified non-industrial private forest owners who agree to follow a state-approved forest stewardship plan for their property. This new federal program also provides funding support to each state for educational projects that promote the forest stewardship concept and increase program awareness and participation. Illinois has a diversity of new and innovative projects including a stewardship magazine, a third grade educational kit and a landowners stewardship program based on a comprehensive landowners guide and in service workshops.

Diseases of Illinois Forests

H. Walker Kirby, Department of Plant Pathology, University of Illinois

This talk will focus on major and minor forest diseases and disorders throughout Illinois. Emphasis will be on all factors which influence diseases and disorders including weather, choice of tree species, planting site, and related management activities. Identification of major problems and management activities to lessen the impact for both the short term and the long term will also be addressed.

Wild Flowers of Illinois Forests

Floyd Swink, The Morton Arboretum

In this talk, a survey will be made of the principal herbaceous plants associated with the forest communities of Illinois.

State and Federal Programs to Assist Forest Management and Stewardship

R. Daniel Schmoker, Division of Forest Resources, Illinois Department of Conservation

Presentation will include description of technical services, advice and plans to landowners. Also included will be descriptions of the cost share programs available to help landowners carry out forest management practices. Included programs: Illinois Forestry Development Act, Agricultural Conservation Program, Forestry Incentives Program and the Stewardship Incentives Program.

Diversity and Management of Forest Communities in the Shawnee National Forest

Lawrence R. Stritch, Shawnee/Wayne-Hoosier National Forests, U.S.D.A. Forest Service

Encompassing in excess of 267,000 acres, the Shawnee National Forest contains a rich and unique diversity of forest and woodland natural communities. The Shawnee National Forest is divided into five distinctly different natural divisions: Shawnee Hills, Coastal Plain, Lower Mississippi River Bottomlands, Wabash Border, and Ozark Hills. Forest natural communities range from the true swamps of the Coastal Plain to xeric pygmy oak woodlands of the Shawnee Hills. This paper will present an overview of the vegetation and structure of these natural communities and management strategies that are being developed and implemented to restore these remnants of our natural national heritage.

Structure and Function of Illinois Forested Wetlands Under Disturbed Hydrologic Regimes

Sandra L. Brown, Department of Forestry, University of Illinois

Many of the forested wetlands in southern Illinois have been subject to alterations in their hydrologic regime. The effects of these alterations on the composition, regeneration and growth rates of several wetland forests in Illinois were measured. In altered stands, growth rates were significantly lower regardless of tree age than unaltered areas, and recruitment of dominant species was practically non-existent. However, the magnitude of these changes was different for different tree species. Changes in sedimentation patterns and mean high and low water depth and duration were important in explaining these trends.

The Challenge: Biography of Illinois

Jon Duerr, Kane County Forest Preserve District and Past President, Illinois Native Plant Society

The diversity of plants in Illinois is related to all of the physical and cultural influences present. The physical features are created by historical events and processes. Not only in the State over 500 miles from north to south, but the exposed land forms range from a few thousand years to well over ten million years in age. The challenge is to relate and map this diversity. I am challenging you to look closely at your home area--your favorite nature area--your drive to work. Where are the plants growing? Examples: *Quercus muhlenbergii* is found at four sites in Kane County and numerous locations in Kendall, all along the Fox River. *Crataegus pruinosa* is scattered in northern Kane County, *Crataegus macrosperma* in very northern Kane County, while *Aralia nudicaulis* occurs at four sites in northern Kane County. A closer look at these species shows a definite pattern in Kane County. *Aralia nudicaulis*, a very common plant in central and northern Wisconsin, is only found behind (north) of a sublobe of the Wisconsin glaciation. *Crataegus macrosperma* is only behind the same sublobe and only on well drained soils. *Crataegus pruinosa* is scattered, but a closer look reveals it only on sandy soils. I am asking you to record your finding by longitude and latitude and Township Section from USGS maps. A committee of the Society is planning a means to record these data. We do not have to only deal with rare species. The changing landscape calls for us to know all of our native species. This is a program in which we can all become involved.

Cultivating a Land Ethic: Who are the Stewards of Illinois Forests?

Timothy D. Marty, Department of Forestry, University of Illinois

Forest stewardship in Illinois is influenced by many factors including land ownership. Over ninety percent of the forestland in the state is owned by private landowners who possess a great diversity of individual attitudes and circumstances. Efforts to improve forest stewardship can be enhanced by more fully understanding those who make land management decisions. Recent surveys of forest landowners in Illinois provide information useful for guiding forest stewardship activities.

Deer in Illinois Forests

Todd Strole, Division of Natural Heritage, Illinois Department of Conservation

A brief history of the Illinois deer herd during the past 100 years will be presented, as well as current populations parameters and herd densities for white-tailed deer in Illinois. A general review of current literature and knowledge concerned with large herbivores browsing will include topics such as: the effects of browsing on forest communities, selective browsing, and forest recovery. The implications this knowledge has on our management strategies from a community ecology perspective is far reaching.

Upland Forests of Central Illinois: Past and Present

Roger C. Anderson, Department of Biological Sciences, Illinois State University

Central Illinois upland forests range from xeric communities occurring on deep sand deposits along the Illinois River, dominated by black and blackjack oak, and black hickory, to forests dominated by shade-tolerant mesophytes on sites with silt loam soils. On finer textured soils, forests segregate on the basis of topography, and include dry-mesic communities dominated by black and white oak on exposed upper slopes grading into mixed oak-hickory, elm, ash dominated forests on gentle slopes and level topography to sugar maple, elm, black walnut, and red oak dominated forests in sheltered locations. Historically, periodic fires maintained open canopies in these forests and encouraged oak regeneration. Because of canopy closure, oak reproduction has been markedly reduced and tree species diversity is markedly declining.

The Presettlement, Present, and Future Forests of the Shawnee and Ozark Hills Regions of Illinois: Management Implications

James S. Fralish, Department of Forestry, Southern Illinois University

Witness-tree data from the 1806-7 original land survey records were used to reconstruct presettlement forest community landscape patterns. Section and quarter-section corners were located on topographic maps and categorized by aspect and slope position. Six site types were recognized: rocky south slope, south slope, ridgetop, high north slope, low north slope and stream terrace. Species importance values and community basal area, average diameter and density were calculated for each type.

The Shawnee Hills region is characterized by massive sandstone bedrock, a thin loess cap which often contains a fragipan, and gently to moderately rolling topography. In the Ozark Hills region, the fractured limestone bedrock is covered by a deep loess cap on the ridges; the valleys have steep slopes and are relatively narrow and deep. The Ozark Hills is situated along the east bank of the Mississippi River which protected the area from eastward moving wildfire; the Shawnee Hills has no natural firebreak.

Data on relatively undisturbed, compositionally-stable (henceforth called "old growth") and disturbed second-growth forest communities were obtained from about 275 circular 0.04-ha plots in the Shawnee Hills and 92 circular 0.01-ha plots in the Ozark Hills. Sapling (0.004 ha) and seedling (0.003 ha) plots were nested within the larger tree plots. Relative basal area and relative density were used as an importance value for trees and saplings/seedlings, respectively.

In the Ozark Hills region, white and black oak were found to be the dominant species on mid to upper south and north slopes and ridgetops; American beech, sugar maple and white oak dominated the community of low slopes and alluvial sites. No land survey corners were located on rocky south sites that presently are dominated by post oak. On five of six site types, oak and hickory were found to have higher importance values in the present forest than in the presettlement forest. However, the sapling and seedling stratum of the present forest on all sites was dominated by sugar maple, American beech and other mesophytic species.

In the drier Shawnee Hills region, post oak was the dominant species on the south rocky sites; white oak was the dominant species on all other site types including stream terraces. This pattern suggests that fire was either more severe or frequent since only one or two maples were recorded in a sample of over 600 witness trees. The old-growth and second-growth communities on rocky south, south and ridgetop sites have a composition similar to that of the presettlement community. On high and low north slopes and stream terraces, the second-growth community is similar to that of presettlement community while the old-growth community is primarily dominated by sugar maple.

The eventual development of a forest composed of sugar maple, beech, ash, and other mesophytes accompanied

by a mid canopy of flowering dogwood, ironwood and pawpaw is expected to have a long term effect on forest diversity. First, there will be a systematic loss of oak and hickory with the next forest (perhaps 50 to 70 years away). Second, the multilayer canopy of the mesophytic forest will reduce the amount of light reaching the forest floor with a resulting loss of herbaceous species. Finally, the loss of herbaceous plants with its associated insect herbivores and pollinators will likely impact neotropical migrant birds. These relationships suggest that over protection which permits the completion of succession to sugar maple will substantially reduce biodiversity and be substantially more detrimental to the integrity of the forest ecosystem than timber harvesting.

Illinois Savannas: Past and Present

Victoria Nuzzo, Native Landscapes, Natural Areas Consultants

At the time of settlement, oak savanna covered some 11,000,000 to 13,000,000 hectares in the Midwest. Presettlement aspect ranged from brush prairie (oaks hidden by prairie vegetation) to scrub savanna (dense oak sprouts overtopping a prairie matrix), to open savanna (widely spaced oaks above prairie), to closed savanna (closely spaced oaks above prairie and/or forest herbaceous vegetation). Present day management for oak savanna is influenced by the existing structure of the community, presence of alien species, and condition of overstory oaks. Management options include prescribed burning, selective removal of understory vegetation, and introduction of native ground layer species. Oak savannas that have succeeded to oak forests may be difficult to restore to presettlement structure.

Poster Session Abstracts

Relation Between Bark Properties and Fire Tolerance of Central Hardwood Tree Species

Gretel E. Hengst and Jeffrey O. Dawson, Department of Forestry, University of Illinois

Increased use of fire as a silviculture management tool in central hardwood forests has prompted a study to determine, in selected species, the protective properties of bark in relation to fire resistance. Measurements of stem diameter and bark thickness were made for several upland and bottomland species to determine the relationship of the two measures across several age and size categories, bark thickness being a widely accepted indicator of fire tolerance. Moisture content, density, dry weight, ignition point, and volatile constituents within the bark were determined as well. Simulated fires conducted in the field provided information about heat flux and maximal cambial temperatures. This combination of data allowed study of heat transfer through bark tissue relative to external and internal bark components and characteristics.

Floristic Surveys on the Shawnee National Forest

Jody P. Shimp and Elizabeth L. Shimp, U.S.D.A. Forest Service, Shawnee National Forest

The Ecosystems Management Unit of the Shawnee National Forest is currently conducting floristic surveys forest-wide. The Botany Program, established in 1989, employs 2 full-time and 1 half-time botanists. In addition, the program also includes botanists employed on a temporary basis, student interns, and volunteers. Surveys have been initiated to locate and identify areas with special vegetation, unique communities, and potential restoration or management needs. Within the last year, over 50 new sites with Illinois endangered and threatened plants have been located and numerous county records documented. During floristic surveys, voucher collections are taken, mounted, information entered into the Forest Service's computer database, and then the specimens are deposited at the Illinois Natural History Survey herbarium. This poster presentation outlines and describes the

survey process from the onset of field date collection to implementation of management.

Monitoring and Status of Endangered and Threatened Plant Species in the Shawnee National Forest

Elizabeth L. Shimp, U.S.D.A. Forest Service, Shawnee National Forest

There are approximately 130 Illinois endangered and threatened plant species that have potential to occur on the Shawnee National Forest. Of these species, 75% are extant on the Forest. As part of the ecosystem management strategy, the Forest Service is actively searching for these species in order to protect and manage the communities in which they exist. In cooperation with the Illinois Department of Conservation, The Morton Arboretum, Southern Illinois University, and other institutions, we have selected and applied methods of monitoring to a number of listed species. Some of the species being monitored on the forest and discussed in this poster presentation include: *Armoracia aquatica*, *Asclepias meadii*, *Botrychium biternatum*, *Calamagrostis porteri* var. *insperata*, *Cimicifuga rubifolia*, *Lilium superbum*, *Matelea obliqua*, *Pinus echinata*, *Plantago cordata*, *Rhododendron prinophyllum*, and *Rhynchospora glomerata*.

Guidelines for Manuscripts Submitted to *Erigenia* for Publication

Manuscripts pertaining to the native flora of Illinois and adjacent states, natural areas, gardening/landscaping with native plants, new distribution records, threats to native species, and related topics are accepted for publication. At least one author must be a member of the Illinois Native Plant Society, otherwise a $25.00 fee will be charged. Non-technical papers from the membership are encouraged. Authors will be charged $15.00 per printed page to help defray the costs of publication. Black and white photos are also accepted. Cost of each photo to the author is $20.00. These charges may be waived upon written request to the editor. Book reviews and art work will be published at no charge when space permits.

Manuscripts submitted to *Erigenia* for publication should be double-spaced throughout except for Literature Cited or References. Three copies must be submitted; photo copies of original manuscripts are acceptable during the review process. Pages should be numbered, and tables and figures should be numbered consecutively. Longer articles should follow as much as possible this general format: abstract, introduction, materials and methods, results, discussion, summary, acknowledgments, and literature cited. Titles of journals should be spelled out completely. The style for citing literature is that of the most recent issue of *Erigenia* (excluding *Erigenia* 13). All measurements should be expressed in metric units with English equivalents when appropriate.

Each manuscript received will be reviewed by three or more members of the editorial board or outside reviewers. After review, authors will be notified of the acceptance or rejection of manuscripts. Accepted articles will be returned to authors for revision. *Erigenia* is prepared on a Personal Computer using WordPerfect 5.1 and 6.0. If a manuscript is prepared on a word processor, the editor will furnish the author with basic instructions to simplify program conversions.

Manuscripts and inquiries should be sent to:

Elizabeth L. Shimp
U.S.D.A. Forest Service
Shawnee National Forest
901 S. Commercial St.
Harrisburg, IL 62946

Note from the Editor regarding *Erigenia* 13

Erigenia 13 did not go through the normal editorial process as described above due to the nature of its contents. A special editorial committee was appointed to review the submitted manuscripts following the conference. The members of the committee were Jeffrey O. Dawson, John E. Ebinger, Kenneth R. Robertson, and myself. Due to time constraints, many of the manuscripts were reviewed by only one or two committee members. For the most part, the contents of the manuscripts were left intact to reflect the essence of the talks presented at the Illinois Forest Conference. In addition to the submitted papers, we have also included in this issue the original conference schedule, abstracts for papers which were not submitted, and poster session abstracts. We thank everyone that was involved in making the conference a success.

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Illinois Native Plant Society
Forest Glen Preserve
R.R. # 1, Box 495A
Westville, IL 61883

Westville, IL 61883

ADDRESS CORRECTION REQUESTED

ERIGENIA *June 1994*

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(continued on inside back cover)

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Number 14
November 1995

Journal of the Illinois Native Plant Society

ERIGENIA

Number 14, November 1995

The Illinois Native Plant Society Journal

The Illinois Native Plant Society is dedicated to the preservation, conservation, and study of the native plants and vegetation of Illinois.

ERIGENIA is named for *Erigenia bulbosa* (Michx.) Nutt. (harbinger of spring), one of our earliest blooming woodland plants. The first issue was published in August 1982.

(ISSN 8755-2000)

COVER ILLUSTRATION

Original drawing of *Isotria medeoloides* (Pursh) Raf. by Nancy Hart Stieber, staff artist at the Morton Arboretum.

MEMBERSHIP

Yearly membership includes a subscription to ERIGENIA and the quarterly newsletter, THE HARBINGER. For more information write to:

Illinois Native Plant Society
Forest Glen Preserve
20301 E. 900 North Road
Westville, Illinois 61883

ERIGENIA

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About Our Authors

MARK A. BASINGER found his additions to the flora of Illinois as part of his continuing Ph.D. work at Southern Illinois University on the effects of disturbance on native flora. Mark has also developed an interest in Illinois lichens.

ROBERT TODD BITTNER is a restoration biologist with The Nature Conservancy at Nachusa Grasslands. His paper reflects part of his Master's work at Southern Illinois University. His special interest is in quantitative monitoring of the habitat requirements of native plants.

H. DAVID CLARKE received both his M.S. and Ph.D. degrees at the University of Illinois at Urbana-Champaign, working on the tropical American Acacias. His is doing a post-doctoral taxonomic study in Guyana.

BRIAN K. DUNPHY, who is currently a graduate student in plant ecology at Michigan State University, got his undergraduate degree at the University of Illinois at Urbana-Champaign.

JOHN E. EBINGER, a mentor to many Illinois botanists and a frequent contributor to ERIGENIA, will retire in December 1996 as head of the Botany Department at Eastern Illinois University. He will, however, continue his studies of Illinois forests and the Acacias of North and South America. He is also known for his systematic work on the genus *Kalmia*.

DON GARDNER is a retired dentist whose two papers in this volume of Erigenia relate to prairie restorations that he began in 1974 on his family's farm. See also, the winter 1996 issue of THE ILLINOIS STEWARD for his article "A Projectile Point and Prairie Ashes."

DOUGLAS J. HAUG is presently serving in the Peace Corps in Bolivia as an agricultural adviser. His survey on woody vegetation, reported here, was done as part of his Master's thesis at Eastern Illinois University.

KENNETH C. JOHNSON, a restoration and botanical consultant in the Chicago area, assists the botany research group at The Morton Arboretum. He currently is conducting a plant survey of a ravine in Kane County.

LINDA A. MASTERS has been with the Research Department at The Morton Arboretum since 1986. Many also know her as one of the early organizers of the annual *Thismia* Hunt in Chicago's south side prairies. Linda is currently working on her Master's degree in ecology at the University of Illinois at Chicago.

JEFFREY W. OLSON is a Master's student in botany at the University of Illinois at Urbana-Champaign. His continuing interest in the ecology of hill prairies began as an undergraduate student at the University of Minnesota.

KENNETH R. ROBERTSON, a botanist at the Illinois Natural History Survey, recently co-authored the magnificent book ILLINOIS WILDS. His special interests include the systematics of the rose, amaranth, and morning glory families. He also was a major contributor to the generic flora of the southeastern United States, published serially in the JOURNAL OF THE ARNOLD ARBORETUM.

MARK W. SCHWARTZ received his Ph.D. at the University of Minnesota, where he studied the factors involving the rareness of *Torreya*. He was with the Illinois Natural History Survey for five years as a plant ecologist, and is now with the Section of Plant Biology at the University of California at Davis.

JOHN E. SCHWEGMAN has been a frequent contributor to ERIGENIA since its inception. As he moves toward retirement from the Illinois Department of Natural Resources, he expects to continue his prolific writing on Illinois natural history subjects. John has contributed greatly to our knowledge of the Illinois flora, and is a principal architect of the natural divisions map of Illinois and the comprehensive plan for the Illinois nature preserve system.

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ILLINOIS' SMALL WHORLED POGONIA ORCHIDS

John E. Schwegman[1]

On Saturday afternoon, October 20, 1973, the late Dr. Julius Swayne of Herrin picked up Mike Homoya and Loyal Mehrhoff of Carterville and headed to Randolph County to inspect a tract of land that one of his students had offered for sale. Julius was a botanist who taught biology at Rend Lake College. Mike was a student of botany at Southern Illinois University, and Loyal was a high school student. The goal of the trip was to see if Julius wanted to purchase the land.

They were impressed by the rugged topography of the tract, and after locating a stand of ground cedar (*Lycopodium digitatum*), which was rare in those days, they decided to search for other interesting plants.

Walking about five meters apart, they were easing along a north-facing slope above a sandstone cliff when Mehrhoff called out that he "had something interesting." What he had was a stalk about ten inches tall with two orchid capsules at the top! A check of the area revealed three more such stalks, all of which had shed their leaves.

Their speculation in the field was that perhaps it was a deformed lady's slipper orchid with two capsules together—that is, until they noticed that the leaf scars were in a whorl. Back home with manuals at hand, they readily identified the fruiting specimen as one of North America's rarest native orchids, the small whorled pogonia (*Isotria medeoloides*).

Swayne purchased the land, and the discoverers settled back for a long winter of anticipation over what the spring would bring. As the year's new growth began, the trio began regular visits in search of flowering small whorled pogonias, and in mid May they were rewarded with the discovery of four plants.

Over the remainder of the 1970s, this site received considerable study by its discoverers. First came the research of Mike Homoya, who included it in his Southern Illinois University master's thesis (1977) on the distribution and ecology of the genus *Isotria* in Illinois. This was followed by Loyal Mehrhoff's University of North Carolina thesis (1980) on the reproductive biology of the genus *Isotria* and the ecology of *Isotria medeoloides*. This study included the Illinois locality as one of his ecological study sites.

It is remarkable that the discovery of this rare plant is so closely tied to the careers of two botanists who are prominent in the conservation of native plants today. Homoya is a botanist with the Indiana Division of Nature Preserves and recently published the definitive book *Orchids of Indiana*. Mehrhoff went on to get his doctorate in botany at the University of British Columbia and now works on the conservation of Hawaii's endangered flora.

Julius Swayne visited the site of this orchid population annually from 1974 until his death in November 1994. I joined him for the annual mid-May census visits from 1981 through 1994. Swayne's notes included information on which plants emerged each year and what their flowering status was. In some years he also determined whether seed capsules matured. In 1983 and from 1985 on, I added measurements of stem height to the leaf whorl as a measure of individual plant vigor.

In addition to the spring visits, Swayne made sporadic visits in the fall to check for capsule development and seed set. I established a permanent demographic monitoring plot in 1986 that included plants #5, #7, and #8. It was half of a circular plot with a radius of one meter for 180 degrees containing 1.57 square meters (Schwegman 1986). The plot aided in locating the exact spot where each plant within it should emerge.

Using information Swayne and Homoya had given me, together with my notes, I pieced together what is known about the appearance, disappearance, vigor, fruiting, and fate of the eight individual stems of small whorled pogonia orchid that were observed over the 21-year time span from 1974 to 1994.

This paper documents what we know about the Illinois small whorled pogonia orchids and their habitat, and speculates on the factors responsible for the observed year-to-year variation in population size and vigor.

[1] Illinois Department of Natural Resources, Division of Natural Heritage, 524 South Second Street, Springfield, IL 62701-1787

Small whorled pogonia orchid and associated vegetation in its Illinois habitat.

The small whorled pogonia in Illinois grows in an area of the Shawnee Hills of the Interior Low Plateaus physiographic province that was covered by the Illinoian glacier. This is a unique situation, as most of the Shawnee Hills are driftless. Schwegman et al. (1973) recognized the distinctive flora and geological history of this region in designating it the Central Section of the Ozark Natural Division of Illinois.

In spite of the past glaciation, the orchid habitat is in a rough ravine and bluff area adjacent to a semi-permanent stream. The plants grow on a slope averaging 31 degrees with an aspect 30 degrees west of north. They are above and about 5 meters south of a 16-meter high cliff of Degonia sandstone of Mississippian age. This same sandstone underlies the entire habitat.

The soil is a silty clay loam with a pH of 4.1 (Mehrhoff 1980). It averages 20 cm or less in depth and measures just 13.5 cm to bedrock in the demographic plot.

Vegetation consists of an open forest of small trees that rarely exceed 30 cm dbh (Homoya 1977). This forest appears to owe its character to soil conditions that restrict tree growth and foster windthrow of trees that reach any great size (Homoya 1977). This open forest, together with the canopy gap associated with the cliff, provides relatively high light levels for an upland forest in southern Illinois.

Mehrhoff (1980) described the vegetation in the orchid's habitat at this site. He found the dominant trees to be *Quercus rubra*, *Quercus alba*, *Amelanchier arborea*, and *Ostrya virginiana*. He listed the most important shrubs as *Amelanchier arborea*, *Ulmus alata*, and *Vaccinium vacillans*, and associated herbs as *Lysimachia lanceolata*, *Polystichum acrostichoides*, and *Solidago buckleyi*. Other associated plants that I feel give an idea of the ecological setting include *Cunila origanoides*, *Luzula multiflora*, *Asplenium platyneuron*, and *Cladonia* sp.

Over the 21 years of observation from 1974 through 1994, a total of eight different orchid stems were observed (table 1). Except for 1976, 1979, and plant #2 in 1974, notes were not made on the flowering condition of individual plants in the 1970s.

Plants #1 through #4, all that were known from 1973 through 1979, grew in one block of habitat measuring 5 meters east to west and 3 meters north to south. In 1980, Julius Swayne discovered plant #5 growing 11 meters west of the others. In 1982 he found plant #6 some 3 meters south (upslope) of plant #2, the most southerly of the original four plants. Plants #7 and #8 eventually appeared near plant #5. The total known habitat block has a length of 16 meters and a width of 6 meters.

In addition to noting flowering condition, beginning in 1985 Swayne and I measured the height of stems from the soil surface up to the leaf whorl and noted the number of flowers, if any, as a measure of individual plant vigor. Some data were obtained on fruiting as well.

Environmental factors that may influence the orchid's vigor and numbers are rainfall, unusually high temperature, and storm damage to the tree canopy within the habitat. Damage by foraging rodents may also have influenced the survival of two plants.

TABLE 1. Annual status of the eight stems of small whorled pogonia orchid found at the Randolph County site from 1974 through 1994.

Year	Plant number 1	2	3	4	5	6	7	8	Total plants
1974	?	F	?	?					4
1975	?	?	?						3
1976	F	F	F						3
1977	?	?	?						3
1978	?	?	?						3
1979	F								1
1980	S				F				2
1981					F				1
1982					F	F			2
1983					F				1
1984					F				1
1985					F	S	F		3
1986					F	S			2
1987					F				1
1988					F				1
1989									0
1990									0
1991								S	1
1992									0
1993									0
1994									0

F = flowering; S = sterile; ? = unknown; blank = not found

While there are no climatic data from the immediate area of the population, precipitation data are available from Chester some 14.5 km away (fig. 1), and temperature data exist for Sparta, which is 26 km away. At this writing, data for 1994 are not available.

Average annual precipitation for Chester is 101.7 cm. Over the course of our observations rainfall was above average fourteen years and below average seven. The wettest protracted period was 1982 through 1986. The wettest year was 1990. The driest year was 1976, and the only period of two consecutive below average rainfall years was 1988 and 1989.

Field climatic notes indicate that in spite of above average rainfall at Chester in 1987 there was a severe summer drought at the orchid site. The summer drought at the site in 1988 was also described as severe in these notes.

Temperatures at Sparta exceeded 100°F in six years. These were 1978 (102°F), 1980 (108°F), 1983 (105°F), 1987 (105°F), 1988 (103°F), and 1991 (103°F). Extremely high temperatures and dry conditions occurred together in 1980, 1987, and 1988.

A severe thunderstorm in July of 1980 broke one tree off and uprooted another in the vicinity of the original population. A treetop dropped on some of the orchid's habitat and increased light levels on the rest.

Another disturbance was "rodent" digging that occurred during the flowering season at or near the site of single known plants in 1989 and 1994. From the size of the holes, it appears the digging was done by the eastern chipmunk, which is known from the area.

The appearance and vigor of each plant are discussed below with reference to the various vigor measurements and the environmental variables that may have influenced them.

Plant #1 was one of the original 1974 plants and was seen annually from that year until 1980, after which it disappeared. Its flowering status in the 1970s is unknown except that it flowered in 1976 and 1979. It was sterile in 1980. It probably produced seed in 1973. Its seven years of appearance were second in longevity to plant #5. Its disappearance followed storm damage, which opened the forest canopy in July 1980 and left a treetop on the plant. The year 1980 also had the lowest recorded precipitation and highest summer high temperature (108°F) of any year during the monitoring period. The hot, dry conditions, at the same time much of the shade was removed, may account for its demise.

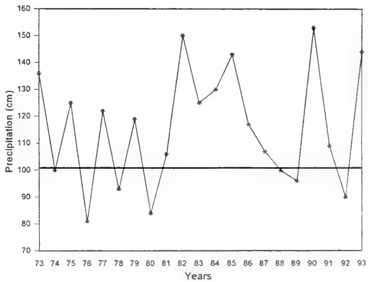

FIG. 1. Total annual precipitation at Chester, Illinois, 1973 to 1993. Average annual precipitation is 100.85 cm, indicated by a heavy line on the graph. Data are from National Oceanographic and Atmospheric Administration Annual Climatological Summaries for Illinois.

Plants #2 and #3 were seen annually from 1974 until they disappeared after the dry and hot year of 1978. Precipitation that year was well below normal, and summer high temperatures reached 102°F. Plant #2 was recorded as flowering in 1974, and both #2 and #3 flowered in 1976. Both may have produced seed in 1973. Their disappearance may have been drought related.

Plant #4 was a second stem that appeared to arise from the same root crown as plant #3 in 1974. Its flowering status was unknown, and it was never seen again. It may have appeared in response to the high moisture levels of 1973 that were not achieved again during the known life of plant #3. This was the only observation we made of two stems apparently arising from the same root crown in the same year.

Plant #5 was first discovered in 1980 some distance from the first known population and may have been present but undetected for some time. It was observed in flower annually from 1980 through 1988. Although it flowered every year, it varied in vigor, as reflected in the number of blossoms produced. In 1984, 1986, and 1988 it had a single flower; in each of the other years it had two. Its average stem height for five measured years was 18.6 cm; it attained a maximum height of 22 cm in 1983. It produced one seed capsule in 1981 and again in 1987. It was not impacted by the forest canopy disruption of 1980.

With nine years of annual observation, plant #5 was the longest lived of the orchids monitored. It disappeared in 1989 after the below normal precipitation and high summer temperatures of 103°F in 1988. It had survived the even higher temperatures and lower rainfall of 1980, but perhaps the two consecutive hot, dry years of 1988–1989 stressed it more than a single very hot, dry year.

On our 1989 visit, we saw a freshly dug 4 cm diameter mammal hole that had been dug about 4 cm upslope from the 1988 orchid stalk. The hole exceeded what we thought was the root level of the plant and probably impacted some of its roots. It was so fresh that we judged it had not caused the failure of the plant to emerge at the site of the previous year's plant. My best guess is that its disappearance was drought related since 1988 was a severe drought year. Rainfall at the site may have been considerably less than at Chester.

Plant #6 was first found as a flowering plant in 1982 upslope from the original population in an area less impacted by the 1980 storm damage. After producing seed in 1982, it disappeared for two years and then reappeared in 1985 and 1986 as sterile plants 7 cm and 8 cm tall respectively. The year 1982 was significantly above average in precipitation, and both 1985 and 1986 followed wet years. There is no drought year to explain the disappearance of this plant in either 1983 or 1987.

Plant #7 appeared as a stem 11.5 cm tall in 1985 and flowered with a single blossom. It had not been seen before and was never seen again. It was just 65 cm from plant #5 and within the demographic plot that was later established in 1986. Its exact location was checked annually through 1994. Its appearance during the longest wet period of our observations indicates that it may have been stimulated to emerge and flower by above average moisture levels.

Plant #8 arose in 1991 as a small sterile plant 5.7 cm tall just 9 cm from the former site of plant #5. This was the third year after plant #5 disappeared. Plant #8 was gone by late July of 1991 when Julius Swayne visited the area and found no evidence of disturbance or what had taken it. Loyal Mehrhoff

Illinois' small whorled pogonia orchid plant #5 as it appeared in 1981.

advised me that small sterile plants arising from the roots of larger small whorled pogonias are not uncommon in the eastern states. These often occur as lines of small plants radiating out as much as 15 cm from the parent plant. Plant #8 may have been a root sprout from plant #5, stimulated to appear by the wettest year of the monitoring period, 1990. In 1994 a small freshly dug hole, the appropriate size for a chipmunk, was found at the exact site where the plant had been in 1991. It is possible that the plant had emerged but was eaten or destroyed a few days before we got there.

Several general conclusions can be drawn from the above information, both about the habitat and ecology of the species in Illinois and about its life history here.

Its Illinois habitat is unique because it is on a rare glaciated, upland, bedrock-controlled surface. The specific site has a rare combination of low forest canopy density typical of drier upland sites and a moderation of xeric conditions due to topographic position. The thin soil depth over bedrock keeps trees small, and the adjacent cliff and canyon provide a canopy gap that allows in more light. The position on a steep north-facing slope and the influence of the adjacent canyon modify what might otherwise be a drier environment. Because the combination of these features is so unique, suitable habitat for this species may be extremely limited in Illinois, and the species is not likely to be found at many other sites.

The appearance and disappearance of individual small whorled pogonia plants in Illinois seem to be related to moisture and possibly high summer temperature. Plants tend to appear after wet years and disappear after dry years, especially dry years with higher than average summer temperatures.

All but one of the plants that appeared in more than one year emerged annually without skipping years until they disappeared. The exception to this was plant #6, which flowered and then had a dormant period of two years before reappearing as a sterile plant two years in a row. Over the 21 years of observation reported here, dormancy was a rare feature of this species.

Most Illinois small whorled pogonia orchids appear for periods of five years or less and then disappear. The two exceptions to this are one plant that appeared seven consecutive years and another that emerged in nine consecutive years.

Seed production occurs at infrequent intervals, usually associated with exceptionally wet years. As far as is known, seeds were produced only in 1973, 1981, 1982, and 1987.

With no live plants of this species having been seen over the past three years, it is possible that this native orchid has disappeared from Illinois. However, lacking information on how long it takes this species to reach flowering condition from seed, we may still be waiting for flowering plants from the big 1973 seed crop to emerge. Only time and careful observation will tell.

This article is dedicated to the memory of the late Dr. Julius Swayne of Herrin, Illinois, who played a major role in the discovery, preservation, and monitoring of the small whorled pogonia orchid in Illinois. I feel honored to have known him and to have been invited to join him in monitoring the population on his land. We spent many enjoyable days in the field. Over the years Julius provided me with his observations of the species, and many of them are included here.

I also want to thank Mr. Michael Homoya for information on the species in the early years of observation and for commenting on aspects of the manuscript. Dr. Loyal Mehrhoff also provided personal observations on the species both in Illinois and elsewhere in its range.

Addendum: searches at the site in 1995, after completion of this manuscript, failed to find any small whorled pogonias.

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THISMIA AMERICANA N. E. PFEIFFER, A HISTORY

Linda A. Masters[1]

ABSTRACT: *Thismia americana* N. E. Pfeiffer is one of the most unusual plants ever to have been found in North America. It is a vascular plant discovered in southern Cook County, Illinois, in 1912, observed and studied for five years. It has not been seen in the wild since. Very little is known about the natural history of this plant; therefore a certain amount of mystery surrounds it. Many people have speculated on the continued existence of *T. americana*, the nature of its habitat, the extent of its range, and even its nativity. This paper attempts to bring together what is known about this plant and discusses the possibilities of its rediscovery.

In early August 1912, Norma Etta Pfeiffer, a graduate student in botany at the University of Chicago, and another graduate student took a field trip to a site not far from the city. In a 1985 letter to Robert Mohlenbrock, she wrote that this site was often used by botany students studying the local flora. Dr. Pfeiffer wrote to a former colleague in 1984 that she and her field companion had gotten teaching jobs for the following year and "had made several collecting trips together to have stuff on hand, if our colleges lacked it. This time we were looking for liverworts, low forms that grow flat on the ground. So we were on hands and knees for that when I found *Thismia.* She [Pfeiffer's companion] was on the same ground and never saw it!" Of course Dr. Pfeiffer did not know it was *Thismia* at the time. What she saw was a tiny white plant, which she carefully collected and took back to the university for further study.

In her letter to Mohlenbrock, Pfeiffer also wrote that she consulted her professors Charles Chamberlain and William Land as to the identity of this plant; she even sent a specimen to John Coulter who was vacationing in Indiana. They confessed that they had never seen a plant like it before, but finally determined that the plant belonged in the Burmanniaceae. This was very unusual, since most members of that family are tropical and usually are found in rich-loamed primeval forests that receive great amounts of rainfall (Jonker 1938; Maas et al. 1986; Fernald 1931).

Norma Pfeiffer had discovered not only a new temperate zone species of this family, but a genus new to North America! She named and described this mysterious plant in her dissertation, "Morphology of *Thismia americana,*" published in the *Botanical Gazette* (Pfeiffer 1914a). The genus name, *Thismia,* is an anagram commemorating Thomas Smith, an English plant anatomist of the early nineteenth century (Fernald 1931; Gleason 1952). The location and habitat information accompanying Pfeiffer's Latin description of *T. americana* simply reads "Chicago, Ill., in open prairie, N. E. Pfeiffer." Later in the paper, she described the location of the discovery and the habitat:

> . . . in a small space along the margin of a grass field . . . [in] a low prairie, characterized by such plants as *Solidago serotina* [= *S. gigantea*], *S. tenuifolia* [= *S. graminifolia*], *Rudbeckia hirta, Eupatorium perfoliatum, Asclepias incarnata, Iris versicolor* [= *I. virginica* var. *shrevei*], *Acorus calamus, Agrostis alba* [var.] *vulgata* [= *A. alba*]; and on the soil itself *Selaginella apus* [= *S. apoda*], *Aneura pinguis*, and *Hypnum*. Usually the *Thismia* grows in spots where the soil is not closely covered by *Aneura* and *Selaginella,* but it may be found occasionally among the moss.[2]

Norma Pfeiffer continued to monitor the plants for the rest of August and into the first half of September, when she obtained fruits. During the winter of 1912–1913, she continued to study the details of the plant's morphology, even trying to germinate the tiny seeds. The attempts, however, were "fruitless" (Pfeiffer 1914a).

In 1913, from the onset of the growing season, Norma Pfeiffer visited the site weekly. On July 1 she found flower buds and hypothesized that the underground parts had overwintered. She wrote in her dissertation that she felt seed germination could have occurred but may have been overlooked. Pfeiffer

[2] Pepoon (1927) credited Pfeiffer and Cowles as describing the habitat as a "sedgy swamp associated with *Selaginella* [*apoda*], near Lake Calumet."

[1] The Morton Arboretum, Lisle, IL 60532

continued to make observations in 1913 and 1914, collecting specimens for study. These specimens were the basis for her dissertation and for a second article also published in the *Botanical Gazette* (Pfeiffer 1918), entitled "The Sporangia of *Thismia americana*," in which she discussed the plant's reproductive process.

As Pfeiffer described in her dissertation, *T. americana* consists of simple floral axes arising from a root system (see fig. 1). The flowers are 0.8–1.5 cm high on an axis 0.3–1.0 cm high. The perianth tube has six conspicuous nerves and six minor nerves and the mouth of the tube is closed by a disk of tissue with a central circular opening surrounded by a raised ring. Three sepals are equal in length to three petals which are connate at their tips. The three to six leaves are reduced to white scalelike bracts, closely appressed to the floral axis. The entire plant, including the root system, is glabrous and white except in the six divisions of the perianth and in the disk closing the perianth mouth. Those areas are a delicate blue green with the raised ring around the opening in the disk somewhat deeper in color. Only this colored portion (5–6 mm in diameter, 4–6 mm in height) is above the level of the soil or of the surrounding moss. The fruit is 3–4 mm in diameter and 2–3 mm high and cup-shaped. The seeds are 0.5 mm long, 0.2 mm in diameter and are hyaline and reticulate (Maas et al. 1986). Pfeiffer believed that, because of the arrangement of the flower parts, insect pollination would be necessary.

The root system lies more or less parallel to the surface at a depth of only a few millimeters. Pfeiffer found no physical connection of the root system to other vascular plants, although the roots often were in close juxtaposition with other roots. The fungi found in the absorptive region of the root (and not found in the stem) seemed to her to have a connection with water and food supply. In the root there is a very large supply of reserve food in the form of oils and fats.

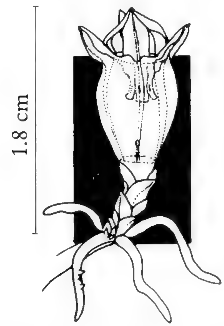


FIG. 1. *Thismia americana* N. E. Pfeiffer. (Drawing by Nancy Hart Stieber.)

The closest relative to *Thismia americana* is *Thismia rodwayi* F. von Müller (fairy lantern). This species is found only in Australia, New Zealand, and Tasmania growing in "gloomy glens on mounds of humus at the base of *Podocarpus dacrydioides* (New Zealand white pine) and other trees" (Campbell 1968). The general habitat of the fairy lantern is damp leaf litter in primeval forests (Maas et al. 1986). *Thismia rodwayi* differs from *T. americana* in the shape and color of the flower and in the root system. *T. rodwayi* can grow to 7.5 cm, the flowers are pale red to yellowish to almost colorless, and the disk closing the perianth mouth is red. Campbell states that "the plant is readily recognized by the small flowers that appear from late October until February, although these are not easily found, since many fail to reach the surface of the forest floor. Only when exposed do they develop to full their very deep salmon-pink color." *T. rodwayi* sometimes lives and flowers completely underground (Maas et al. 1986).

Norma Pfeiffer was 24 years old in 1913, and at the time was the youngest person to have received a Ph.D. from the University of Chicago (fig.2). She left Illinois in 1914 for the University of North Dakota, where she taught botany for ten years. From there she joined the staff at the Boyce Thompson Institute for Plant Research in Yonkers, New York, until she retired in 1959. She died on August 23, 1989, at the age of 100 (New York Times 1989).

Under the *Thismia americana* entry in *Plants of the Chicago Region* (Swink and Wilhelm 1994), a map to the type location, given to the senior author by Norma Pfeiffer, is mentioned. I was curious about the map since nowhere among Pfeiffer's papers had I come across a specific address. I asked Floyd Swink what he knew about this information and he said that in 1948 Norma Pfeiffer had sent him a map on which she gave directions to the site. Soon after Swink received the map, he and his brother went to take a photograph of the area. He said he felt absolutely certain they were in the right spot. "We were at the location on the map, and all the associated plants were there."

FIG. 2. Norma Pfeiffer's graduating class, 1913. (Pfeiffer is in the middle row, third from the right.)

Using the map, Julian Steyermark and Floyd Swink located the area and went on a search for *Thismia americana.* Instead of *T. americana* they found *Ophioglossum vulgatum* L. var. *pseudopodum* (Blake) Farw., which they believed to be new to the Chicago region, and published the find in *Rhodora* (Steyermark and Swink 1952). The authors reported that they found this plant while "on a futile search for *Thismia americana* . . . at its type locality." The collection data for *Ophioglossum vulgatum* var. *pseudopodum* is as follows:

> Bottom prairie swale, on east side of Calumet Lake, between Torrence Avenue and Nickel Plate railroad at about 11900 South, between Ford Plant and Solvay Coke Plant, Chicago, Cook Co., Illinois, June 2, 1949, *Steyermark & Swink 68222.*

The map cannot be located; indeed, Swink believes that he probably had given the map to Steyermark in order to organize forays to the site and that Steyermark may have put it in a file at the Field Museum. In any event, it is now lost to posterity.

On September 19, 1951, a group of Chicago area botanists went on a foray to search for *Thismia americana* at the above location (fig. 3). This foray was reported on in an article published in the *Chicago Sun-Times* (1952). A Chicago acquaintance of Norma Pfeiffer sent her a clipping of the article, which prompted Pfeiffer to write Theodor Just, a participant in the foray, with new information. Until this time it was only known for sure that *T. americana* was seen in the wild from 1912 to 1914. Her letter added two more years based on her collection dates.

> I do not know whether you [Theodor Just] were responsible for the information on which the article was based. But I thought you might be interested in having some data on some of the dates on which I collected plants in flower. You will see it was not nearly so temporary a resident as indicated.
>
> The original collection was made August 5, 1912, and subsequent observation continued that year until mid-September. In 1913, it was again followed through the season (earliest in July) to September 8. For 1914, I have July 29 and 'August', no day specified. In 1915, July 25, and 1916, as late as September 1.

There was no more new material written on *Thismia americana* by Norma Pfeiffer until Mohlenbrock (1985) published in *Erigenia* a letter she had written him in response to the account of *T. americana* in *Where Have All the Wildflowers Gone?* (Mohlenbrock 1983). She wrote that the year following her initial discovery she found *T. americana* on the same site as before but that a year after that a barn had been built on the site. "Good-bye *Thismia*," she wrote. A most interesting piece of new information, however, was her revelation that she had located, about one-third mile away from the original site, a few plants in "the midst of *Typha*" between ancient beach ridges of the post-glacial lake, Lake Chicago.

FIG. 3. Botanists from the 1951 *Thismia* foray. Left to right: Jose Cuatrecasas, Theodor Just, John Thieret, Floyd Swink, Earl Sherff. Not pictured, Julian Steyermark (photographer).

In a 1985 telephone conversation with Bill N. McKnight (pers. comm.), Norma Pfeiffer recalled that although many *Thismia americana* specimens were collected, she did not take all that she saw. She also said that there were no maps made of the plant's location on the site and that no habitat photographs were taken. It is unfortunate that, although Norma Pfeiffer made copious notes on the morphology of *T. americana,* she and others did not realize at the time how important specific habitat, location, and population data would be for future researchers.

This part of southern Cook County, where *Thismia americana* was found, is unique because it is one of the last remnants of an area that was part of the lake plain of the ancient glacial Lake Chicago. The site where it was known to have grown was under the waters of Lake Chicago until a substage, Lake Algoma, began to recede about 2000 years ago (Willman 1971). As Lake Chicago and its substages withdrew, it left behind the swell-and-swale sand deposits that now form well-drained ridges interspersed by wet, calcareous depressions. By 1971, 90 percent of this lake plain had been developed (Willman 1971). It originally was 45 miles long and up to 15 miles wide and it covered approximately 450 square miles. Most of the lake plain was exceptionally flat; the ridges were generally less than ten feet high. What few acres remain of this unique habitat support diverse vegetation, including plants that are disjunct from the Atlantic and Gulf coastal plain and boreal regions of northern Wisconsin and Michigan.

Julian Steyermark and Theodor Just were concerned about the fate of the type location (Tardy 1952). They believed the only way to solve the mystery of *Thismia americana* would be to save the habitat. There are still several areas within a five-mile radius of the type locality that have likely habitat for *Thismia americana.* These would be all of the natural areas still surviving in the lake plain of the lower stage of Lake Chicago: the type location, Powderhorn Marsh and Prairie, Burnham Prairie, Sand Ridge Nature Preserve, Thornton Fractional High School, and the Calumet City Prairie. After Robert Betz discovered Burnham Prairie, owned by Waste Management, in late summer 1974 (pers. comm.), the Illinois Natural Areas Inventory (1976) stated under "significant features" that this prairie would be a likely habitat for *T. americana.* Many of these areas remain unprotected and are still under threat of development (Johnson 1991).

How many hours over the last 80 years have actually been spent in disciplined searches by individuals with good search images for *Thismia?* Although people have been interested in finding this plant over the past 80 years, it would easily be missed, given its size and coloring. The Illinois Native Plant Society has been sponsoring annual *Thismia* hunts since 1991.[3] Searchers gathered at a central location before splitting into five or six groups in order to cover all the potential *Thismia* habitat sites. At the end of the day, they met again to discuss their experiences and make note of any plants they found that were new to the Chicago lake plain. Before the first hunt, 200 small white beads were scattered in what looked like potential *Thismia* habitat at two different search sites. During the hunt, none were found at one site and 36 were recovered at the other, but only after the group was led to the area by a leader who knew where the beads were scattered. The second year 200 more beads were scattered at a third site. None were recovered at the new site, but seven beads from the previous year were discovered. There remain 557 "*Thismia*" yet to be found!

Another by-product of the *Thismia* hunts was a discovery by Bill Zales. While rummaging through a used bookstore, he found a set of reprints of articles by Norma Pfeiffer. He purchased all of them and brought them to a hunt. One of the articles, "The Prothallia of *Ophioglossum vulgatum*" (Pfeiffer 1916), expanded on the description of *Thismia* habitat.

> The situation in which the present growth of *O[phioglossum] vulgatum* occurs is practically the low prairie type previously described for *Thismia americana.* The plants of *Ophioglossum* occur among the prairie plants. Spots have been burned, and here the plants show very distinctly, owing to a partial elimination of the grasses and other plants which ordinarily tend to obscure the smaller *Ophioglossum* plants. Where there is much shade, *Selaginella apus* and *Aneura pinguis* occur, as in the *Thismia* patch, which is close at hand. The habitat is evidently low and wet, inundated in spring. Early in July, *Riccia fluitans* in small amounts was also found, and late in July 1915, after a rather wet month, some of the field was under water. There were, however, hummocks as well as more extensive plots not submerged. Compared with the other situation in

[4] One of the hunts, so widely publicized as it was in the Chicago papers, even brought out relatives of Norma Pfeiffer, and they shared family pictures and memorabilia.

> the Chicago region where *O. vulgatum* has been found, that is, near Gary, the present station in the southeast outskirts of Chicago seems wetter.

In 1993 the Illinois Department of Conservation and the U.S. Fish and Wildlife Service commissioned a systematic search of potential habitat for *Thismia americana* (Bowles et al. 1994). It is the rare botanist who has a search image for such a plant and of the three people asked to search, two are skilled at looking for lichens (Rich Hyerczyk and Michael Jones) and another has a reputation for locating small unusual plants (Ken Klick). Unfortunately, the search did not turn up *Thismia*, but it did produce more information about the sites with potential *Thismia* habitat.

Because there is very little information about this plant, and because it has not been seen for a long time, many botanists have listed it as "almost certainly" or "undoubtedly" extinct (Jones and Fuller 1955; Swink 1974; Mohlenbrock 1970, 1975, 1986; Jones 1971; Swink and Wilhelm 1994). Louis O. Williams, former chairman of the Botany Department at the Field Museum, was more optimistic; he wrote in 1973 that it may still be in areas sharing similar habitat characteristics and "that maybe some day an astute collector may find this tiny little plant again." Fernald wrote in *Gray's Manual of Botany, 8th ed.* (1950) that *Thismia americana* was "a most remarkable species, to be sought again." *T. americana* is listed as an Illinois endangered plant (Sheviak 1981; Illinois Endangered Species Protection Board 1990), which optimistically suggests that the plant remains extant. Extirpated species are not state listed unless they also are federally listed, and *T. americana* is not federally listed. Importantly, in her letter to Dr. Just, Norma Pfeiffer reflected optimism that it could be relocated if similar habitat remained.

> In 1917, I hunted briefly, but did not have adequate time for a thoroughgoing search. Since that time, I have often thought of searching similar locations as well as the original station, but have not done so. With enough time, I am sure I could locate it, if it is still in the region.

Two other examples provide reason for optimism. In 1984, Ken Klick found, for the "first" time, a tiny bladderwort, *Utricularia subulata* L., in the frequently visited and intensely botanized Hoosier Prairie in nearby Lake County, Indiana. Botanists had questioned the plant's nativity, but since then, Gerould Wilhelm and I found a specimen of *U. subulata* from Porter County, misidentified as *U. minor* L., in Father Hebert's herbarium at Notre Dame. This specimen was collected in 1930, giving support to the idea that the plant is native in northwest Indiana. Our present knowledge indicates it had been overlooked for more than 50 years despite intensive floristic work (Wilhelm 1990). Another example is a lichen, *Phaeophyscia leana* Tuck., that was first discovered in 1839 near Cincinnati, Ohio, collected for about ten years, and then not seen since. It was thought to be extinct (Thomson 1963) and was even removed from most lichen flora keys. It was rediscovered 139 years later, in 1978, by Alan Skorepa (1984), 200 miles downstream along the Ohio River in southern Illinois. It has since been found in several more locations in four other states (Wilhelm and Wetstein 1991). It has been a mere 79 years since *Thismia americana* was last seen.

How and where would one begin to look to rediscover *Thismia americana*? Norma Pfeiffer first discovered it east of Lake Calumet and north of the Calumet River, in an area that even then was under threat of industrial development. The plants listed by Norma Pfeiffer would suggest a wet area, but what the actual relationship of *T. americana* to the water table was is not known. She found the plant growing mostly where the soil was not closely covered by *Selaginella* and *Aneura*. Did this mean that the area burned on a regular basis, thereby removing the duff and exposing the soil? Perhaps not enough is known about its flowering phenology. Was it consistent from year to year? Was it dependent on certain temperatures or humidities? Was it ephemeral and easily missed? Like *Thismia rodwayi*, does it also bloom underground from time to time?

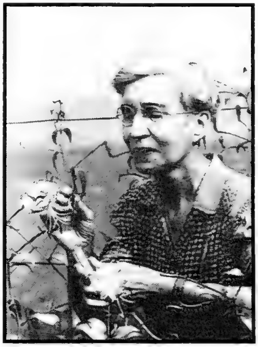
One of the great botanical mysteries is how *T. americana*, which is known from nowhere else in the world, came to occupy these low prairies. Some have suggested that this plant was a waif from some tropical area or disjunct from the coastal plain and, not being able to withstand our harsh winters, eventually disappeared; maybe it is native to the temperate zone somewhere in South America and has not yet been discovered there. Because it has been discovered here and nowhere else, I believe we must proceed on the premise that the plant is native to the Chicago region. Many have asserted that the rediscovery of *T. americana* is a long shot. I would answer that it is not nearly such a long shot as its original discovery. In a charming account in a recently rediscovered journal article written when she first arrived in North Dakota (Pfeiffer 1914b), Dr. Pfeiffer speculated on the "slow

finding of forms" that may bridge the geographic space in the distribution of *Thismia* species. She wrote that it was not the lack of fairly intensive botanical work in the Chicago region, but rather, it was the smallness of the plants themselves that made such discoveries so rare. Of *Thismia americana* she wrote the following:

> . . . the dimensions of the plant appear even smaller than in most tropical forms. As a matter of fact, all of the short floral stalk and the basal portion of the flower are underground, with only the delicately colored upper part evident. The young buds are white, developing later a delicate blue-green in the upper part of the flower. The structure of the flower is quite different from that on forms with which most of us are familiar. . . The petals, which are grown together at the top, are distinctly separate 2–3 mm, while the total height of the flower is only 1–1.5 cm at best. It is evident that when not bearing a flower, the organism would defy detection, unless one uncovered the roots.

She went on to discuss how one should search for the plants that may bridge the distribution gap:

> The general characteristics of such a group of plants as this one undoubtedly call for different tactics in hunting them down from those required in enumerating larger, more persistent forms. But the methods are such as are natural to any one. For those of us who have not access to wide displays of fossil forms, with the technical knowledge required to take advantage of them, who have not the opportunity to develop new species in a cultural way, or who are unable to experience the pleasures with the attendant hardships, of the botanical excursion into unexplored country, there remains the regions about us. In these areas, withal they have been cursorily examined, there may exist at the present time, forms as yet undreamed of.



Norma E. Pfeiffer

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ERIGENIA, Number 14, November 1995, pp. 15–17

THE STATUS OF *ASTER SCHREBERI* NEES (SCHREBER'S ASTER) IN ILLINOIS

John E. Ebinger[1]

ABSTRACT: Populations of *Aster schreberi* Nees were examined at ten sites in the northern one-third of Illinois. Most populations occurred on north-facing, relatively steep slopes in second-growth forests. The overstory above the Schreber's aster populations varied from 232 to 512 stems/ha, and average tree diameters ranged from 22 to 32 cm dbh. Moderate disturbance was evident at most sites, and soil slumping resulted in the loss of some trees. Most aster populations were relatively small, occurring in areas less than 0.5 ha in size. No particular features of the habitat were found to be related to the rare appearances of Schreber's aster in Illinois.

INTRODUCTION

Aster schreberi Nees (Asteraceae) is a common species in dense woods, particularly in the Piedmont and mountains of the eastern and southeastern United States, from Maine to northern Alabama, and west through the Great Lakes region to eastern Wisconsin (Gleason and Cronquist 1991). Illinois populations are disjunct by about 450 km from the nearest populations to the east (Jones 1989). Because of this distribution and the few extant populations in the state, Schreber's aster is presently listed as state threatened (Sheviak and Thom 1981; Herkert 1991). The disjunct Illinois populations have been referred to *Aster chasei* G. N. Jones (Jones and Fuller 1955), but more recently Jones (1989) found no consistent characters for separation of these plants as a distinct species.

Aster schreberi is restricted to the northern one-third of Illinois (Winterringer and Evers 1960; Mohlenbrock and Ladd 1978). It is known from the central part of the Illinois River valley (Bureau, Marshall, Peoria, Putnam, and Tazewell counties) and from northwestern Illinois (Henry, Knox, and Rock Island counties), and it has been reported from Cook and Will counties in northeastern Illinois (Jones 1989). Not only is this species uncommon in Illinois, but flowering individuals are rare. Populations increase in size by rhizomes that form large sterile colonies in which the basal rosettes produce a dense ground cover. The present study was undertaken to determine the size and structure of Schreber's aster populations in Illinois and to characterize the habitat in which these populations occur.

MATERIALS AND METHODS

Location data for all known populations of *Aster schreberi* in Illinois were obtained from Illinois herbaria, and attempts were made to relocate each population. At sites where *Aster schreberi* populations were found, general site and population data were gathered, and at ten sites a detailed site evaluation was undertaken. The woody overstory density (stems/ha), basal area (m^2/ha), relative values, importance values, and average diameters were determined, as was the density (stems/ha) of the saplings. The woody overstory composition was tabulated by using two quadrats, each 25 × 25 m, centered over the *Aster schreberi* population. In these quadrats all trees 10 cm dbh and larger were identified and their diameters recorded. The density of small saplings (> 40 cm tall and < 2.5 cm dbh) and large saplings (2.5 to 9.9 cm dbh) was determined using nested circular plots of 1 m^2 (for small saplings) and 10 m^2 (for large saplings), centrally located in each quarter of each 25 × 25 m quadrat.

RESULTS AND DISCUSSION

Most of the Schreber's aster populations were located on north-facing hillsides that had a slope of 10 to 30 degrees. A few populations were in steep-sided ravines, and one was located on a terrace at the base of a steep slope. Occasionally colonies were found on the flat uplands above the hillsides (table 1).

In the 10 sites studied, there were dense colonies of *Aster schreberi* 4 to 12 m across that grew to the exclusion of most other species. Between these dense colonies were many smaller colonies as well as scattered individuals (table 1). Generally, *Aster schreberi*

[1] Botany Department, Eastern Illinois University, Charleston, IL 61920

individuals were confined to an area of less than 0.5 ha. Two populations, however, were much more extensive. At Thorn Creek Woods Nature Preserve (Will #1) much of the forest had extensive colonies, some as large as 35 m across, located mostly on the slopes of Thorn Creek and the adjacent uplands. The largest *Aster schreberi* population found in Illinois was at Loud Thunder Forest Preserve (Rock Island #1), where it extended for more than 1.5 km along the wooded, north-facing hillside adjacent to the Mississippi River. Numerous dense colonies, some 45 m across, were scattered along this hillside, along with many smaller colonies and scattered individuals.

Few flowering plants were observed at most study sites; six sites contained fewer than 40 flowering individuals during the 1991 survey (table 1); however, at two different sites in the Marshall County State Fish and Wildlife Area (Marshall #3 and #4), nearly 100 flowering individuals were observed. In the largest populations (Rock Island #1 and Will #1) no attempt was made to count the number of flowering individuals because of the size of the areas, but very few were observed. Most flowering individuals were growing in the more open parts of the sites.

The woody overstory at the Schreber's aster colonies was dominated by species typically associated with mesic hillsides and terrace forests. On the steep hillsides *Acer saccharum* Marsh. (sugar maple) was usually the most common species with an importance value (IV) close to 100 (out of a possible 200). *Quercus rubra* L. (red oak), *Q. alba* L. (white oak), and *Tilia americana* L. (American linden) usually followed in importance, though on two sites red oak had the highest IV, and on one white oak dominated. The terrace population overstory was dominated by *Ulmus americana* L. (American elm) with an IV of 80, followed by *Populus deltoides* Marsh. (cottonwood) and American linden. The forests showed indications of past disturbance. Usually a few cut stumps were present, and soil slumping on steep slopes resulted in the loss of some trees. Tree densities varied from 232 to 512 stems/ha, averaging 340 stems/ha for the 10 sites; the basal area varied from 13.9 to 38.3 m^2/ha, averaging 25.7 m^2/ha. Trees were relatively mature with average diameters of 22.4 to 31.8 cm for the 10 sites.

The understory was relatively open and generally dominated by sugar maple, which accounted for nearly 50% of the individuals present. The understory tree *Ostrya virginiana* (Mill.) K. Koch (hop hornbeam) was also common, along with *Fraxinus* spp. (ash) and *Carya cordiformis* (Wang.) K. Koch (bitternut hickory). Common shrubs included *Corylus americana* Walt. (hazelnut), *Staphylea trifolia* L. (bladdernut), *Viburnum prunifolium* L. (black haw), and *Hydrangea arborescens* L. (hydrangea). Shrub and small sapling densities ranged from 2,100 to 9,625 stems/ha, averaging 5,538 stems/ha for the 10 sites; large saplings averaged 770 stems/ha.

During late summer when the study was undertaken, the common herbaceous species found associated with the Schreber's aster populations were *Asarum canadense* L., *Carex albursina* Sheldon, *Cystopteris protrusa* (Weatherby) Blasd., *Eupatorium rugosum* Houtt., *Hepatica nobilis* Mill. var. *acuta* (Pursh) Steyerm., *Polystichum acrostichoides* (Michx.) Schott, *Solidago flexicaulis* L., and *S. ulmifolia* Muhl.

In addition to the 10 sites studied, 12 other populations of *Aster schreberi* were located. All were in the Illinois River valley in the general vicinity of Peoria. Both Robinson Park and Forest Park have extensive north-facing hillsides, and some of these had extensive populations of Schreber's aster. A few additional populations were found at the Marshall County State Fish and Wildlife Area; others occurred in and near the Miller-Anderson Woods Nature Preserve. One population was located in a steep-sided ravine in northwestern Tazewell County (S12 T26N R4W). The majority of the *Aster schreberi* populations were in state and city parks; others were in a university natural area, a nature preserve, and a state fish and wildlife area. Since these areas are protected to some degree, it appears that the survival of *Aster schreberi* in Illinois is relatively secure.

In the Illinois River valley there are many areas with habitats similar to those in which *Aster schreberi* was found, in some cases within a few hundred meters of a population. These areas have the same associated species, but lack Schreber's aster. It appears that the rarity of this taxon in Illinois is probably not related to a specialized habitat, but is most likely the result of the small number of flowering individuals, or possibly poor seed reproduction, poor seedling survival, or low genetic variability.

ACKNOWLEDGMENTS

This work was supported, in part, by a grant from the Illinois Department of Conservation's Wildlife Preservation Fund.

TABLE 1. Colonies of *Aster schreberi* examined in Illinois.

County and site	Extent of *Aster schreberi* population	Flowering individuals
Bureau #1 S36 T15N R9E	110 × 45 m along slope, six colonies 5–18 m in diameter, along with numerous smaller colonies and scattered individuals	3
Knox #1 S6 T11N R4E	45 × 24 m along slope, one colony 8 m in diameter and another 10 × 20 m, along with scattered individuals	20
Marshall #1 S23 T12N R9E	85 × 22 m along slope and terrace, four colonies 5–8 m in diameter, along with numerous smaller colonies and scattered individuals	0
Marshall #2 S34 T12N R9E	75 × 45 m along slope, two colonies 6–12 m in diameter, along with numerous smaller colonies and scattered individuals	10
Marshall #3 S23 T29N R3W	110 × 30 m along slope, seven colonies 4–9 m in diameter, along with scattered individuals	110
Marshall #4 S23 T29N R3W	70 × 15 m along ravine, three colonies about 5 m in diameter and one 20 × 5 m, along with scattered individuals	98
Peoria #1 S22 T9N R8E	45 m along terrace and 35 m up slope, one colony 11 m in diameter, along with numerous scattered individuals	15
Peoria #2 S22 T9N R8E	65 × 35 m along slope, four colonies 2–6 m in diameter, along with scattered individuals and a few smaller colonies	33
Rock Island #1 S26 T17N R4W	1,500 × 125 m along a north-facing hillside at Loud Thunder Forest Preserve, numerous dense colonies and scattered individuals	?
Will #1 S11 T34N R13E	Extensive colonies and scattered individuals throughout much of Thorn Creek Woods Nature Preserve	?

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ERIGENIA, Number 14, November 1995, pp. 18–31

Prairie Restoration on an East-Central Illinois Field

Don Gardner[1]

ABSTRACT: A prairie restoration project was initiated in 1974 on mesic soil pasture land. Restoration of adjacent plots within the field continued annually; the final plot was seeded in 1990. Geological, climatological, and settlement histories are described briefly. Methods of soil preparation, seed treatment, nursery propagation, weed control, and the use of fire are discussed. The floristic composition and observations of successional changes are recorded. An inventory yielded 189 species of native and alien vascular plants. Voucher specimens were collected and placed in a herbarium.

Introduction

This is a report concerning a continuing prairie restoration project on a former pasture in northern Ford County. In the natural divisions of Illinois, it lies within the Grand Prairie Section of the Grand Prairie Division (Schwegman et al. 1973). It is located on the southeast side of the village of Kempton (in part of SW NW NE and SE NE NW S6) in Mona Township. The field shape is roughly trapezoidal, containing over seven acres. The long axis is east-west and is about 1000 feet. Width averages about 325 feet. Intense grazing for many years contributed to the extirpation of many native prairie species. The goal of the project has been to increase populations of remaining desirable native species and to introduce other native species that continue to survive on prairie remnants in central Illinois.

The project began in 1974. The years following provided time for comparisons of restoration methods and observations of species population changes. Although this represents more than twenty growing seasons, it is only a moment in the time span necessary for successional development of climax prairie. This report describes the brief and generally satisfying progress in what is anticipated to be a much longer-term project.

A survey of species established on the restoration was conducted, and voucher specimens were placed on file in the Illinois Natural History Survey herbarium (ILLS) at Champaign. All collections were made from 1991 to 1994.

Glaciation and Topography

Bedrock under this area is the Carbondale formation of the Pennsylvanian system. It consists of thick shaly mudstones interbedded with thin coals, limestones, and sandstones. Above this bedrock are more than 200 feet of glacial till, a generally unstratified mixture of silt, clay, and sand, with inclusions ranging from pebbles to large boulders. It accounts for the principal features of the present topography of the region (Piskin and Bergstrom 1975). The project site lies near the south margin of the Ransom moraine. It has about 80 feet of elevation above a glacial lacustrine region to the southeast.

Rapid plant invasion followed the recession of the most recent glaciation, the Woodfordian phase of the Wisconsinan. Tundra vegetation with scattered spruce and fir forests was followed by a transition to deciduous tree species about 12,000 B.P. Beginning about 6500 B.P., grassland intruded from the west in response to a period of warm, dry climate (Geis and Boggess 1968; King 1981).

The variation of elevation within the restoration field reflects the gently rolling topography. From about 730 feet above sea level at the southwest corner, there is a gradual slope downward to a shallow watercourse passing diagonally through the central part of the field. Water is present in the ditch only during seasonal runoff. There is a difference of about 15 feet from the highest location to where the ditch exits the field (U.S.G.S. 1986).

The watershed draining through the restoration includes a major part of the village of Kempton and fields extending about one-half mile north of the village. Water flow is to the southeast where, in about three miles, it enters what was locally known as the Vermilion Swamp, a wetland that was drained early in the twentieth century. Water then enters the North Fork of the Vermilion River, which flows west and north, eventually entering the Illinois River near LaSalle.

[1] 3584 N 1300 East Road, Kempton, IL 60946

SOILS

Soil types in the restoration are Swygert 91B2, particularly on the higher parts of the field, and Bryce 235 (fig. 1). Both are poorly drained fine-textured silty clay loam soils formed in loess, local outwash, and underlying glacial till. The surface layer is black to dark gray, friable, firm, and about 12 inches thick. Both soils are classified in hydrologic soil groups that have slow infiltration rates when wet, which causes potentially high runoff. These soils are used for cultivated crops, primarily corn and soybeans in the local area. Problems they present for cultivation are ponding in low areas and water erosion on slopes. Contributing to these effects is slow permeability and moderate available water capacity (Fehrenbacher 1990). The compact surface layer and low permeability of these soils cause severe and persistent clodding if cultivated when too wet. Thus, during springs of above average rainfall, timing of cultivation is critical.

A buried drainage tile passes through the restoration, causing localized alterations in soil hydrology. An 18-inch diameter drainage tile from the village enters the restoration site from the north and parallels the ditch to its exit from the restoration. This tile is nonperforated plastic and thus hydrologic modification of the soil is reduced. A 10-inch diameter perforated plastic tile connects to the larger tile after entering the site from the west. A 5-inch diameter clay tile line crosses the site from the southwest and connects to the 10-inch line (fig. 2).

CLIMATIC FACTORS

Marked year-to-year variations in climatic conditions significantly affect the accuracy of any characterization of a typical weather year over the short duration of the study, and the following statistics can be misleading for any brief period of years.

Ford County has a continental climate with cold winters and hot, humid summers. Precipitation is generally adequate. Data recorded in the period 1951–80 at Kankakee established that total annual precipitation averaged about 35 inches. Approximately 65 percent of this fell from April through September. Snowfall averaged 24.8 inches annually. Snow cover can be a protective factor on a restoration, especially for young plants. It provides insulation from the often intense subzero Fahrenheit temperatures and prevents the displacement of recently established plants that results from intermittent freezing and thawing of exposed soil. The number of winter days with a covering of snow varies greatly from year to year (Fehrenbacher 1990).

Established prairie forbs are well adapted to short-term moisture variations and use several protective mechanisms. During stressfully dry growing seasons leaf curling is apparent, growth is curtailed, and anthesis may not occur. During the drought years of 1988 and 1991 the tall warm-season native grasses grew to only about one-third of their usual height, and viable seed was not produced. Rainfall of 11.6 inches in July 1992 established a monthly high record;

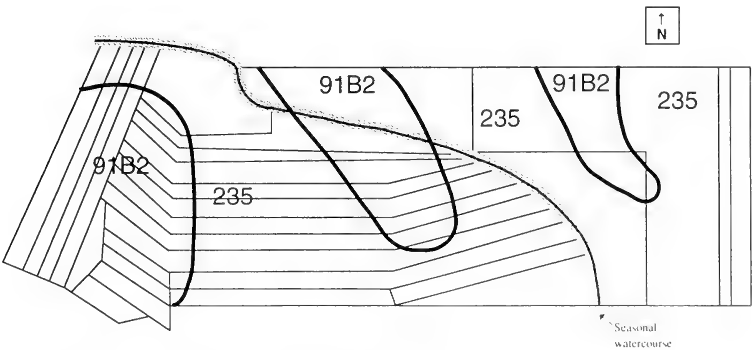

FIG. 1. Restoration site with designations of soil types, Swygert 91B2 and Bryce 235.

however, this was preceded by drought conditions during the spring, with 2.7 inches of precipitation from early April until 2 July. In spite of the wet summer, seed production by the tall native grasses was reduced. This suggests that anthesis is determined early, probably in June. In 1981, a year in which there was above average rainfall (39.7 inches from April through September), some plants of *Andropogon gerardii* (big bluestem) exceeded ten feet in height.

The growing season extends from about mid April until mid October. Two years in ten, killing frost (28°F or lower) occurs later than 20 April or earlier than 18 October (Fehrenbacher 1990). Early or late frost rarely was cause for problems on the restoration. Soon after freezing in the fall, seed falls readily from some grasses; prompt seed harvest is required. The remarkably prolonged resilience of the culms of these grasses was noted. Occasionally ice storms prostrated entire stands of previous season growth of the tall grasses, but following the melting of the ice, the culms rapidly regained their erect stature.

SETTLEMENT HISTORY

The first written records found for the immediate area in which the restoration is located are dated 27 April 1834. It was then that the United States public lands survey was conducted. The survey indicates that all of what is now Mona Township was prairie, with the marshland in the southeast portion described as the "Vermilion Swamp" (Illinois presettlement atlas 1840). Field notes (Ewing 1834) for the survey of Section 6, in which the restoration is located, describe it as "rich first rate prairie." The survey record notes that prairie covered all of Sullivan Township, adjacent on the west. Mona Township was organized in 1870, with a population of 342; major settlement had occurred from 1867 to 1870. Population growth was encouraged by construction of the Bloomington-Kankakee branch line of the Illinois Central Railroad, and the village of Kempton was developed on this newly established line in 1878.

Wright Kemp, who was instrumental in forming the village and owned land including the present prairie restoration, came from Morris in Grundy County to "Grand Prairie, Ford Co." in 1866. He described that journey, by way of Dwight, as traveling "across the unbroken prairie." The 1884 *Historical Atlas of Ford County, Illinois*, in which these comments appear, also describes northern Mona Township as "a fine body of undulating prairie land."

The two subsequent owners of the restoration site used the pasture land to graze dairy cattle throughout the early and mid portions of the twentieth century. Grazing ceased in 1965, and the pasture remained an old field with annual mowing until the start of the restoration work in 1974.

In past years, during conversations with the author, older residents of the community stated that the restoration had been permanent pastureland from at least 1900. It was their opinion that the field had never been tilled, but this could not be documented.

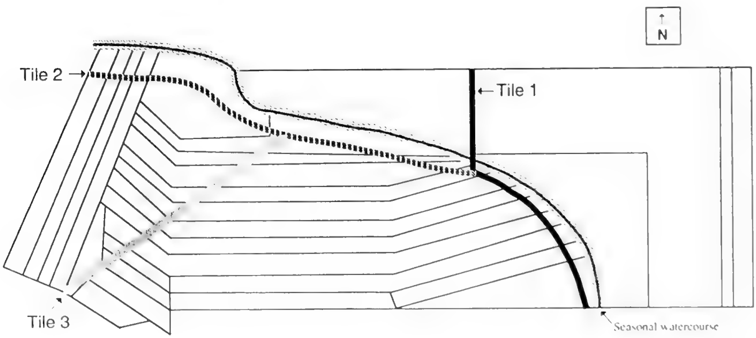

FIG. 2. Drainage tile locations. Tile 1, nonperforated plastic, 18-inch diameter. Tile 2, perforated plastic, 10-inch diameter Tile 3, clay, 5-inch diameter.

METHODS

Plots

From 1974 through 1990, 28 plots were established in the approximately 7.3-acre restoration field (fig. 3). Plot size varied from about 0.044 acre to 1.375 acre (table 1) and was determined by the amount of hand-collected seed available each year. In some years two plots were delineated to test different soil preparation methods and different seed mixes, or to expand restoration into another part of the field. Generally the restoration started at the south side of the field and progressed northward in parallel plots. Most of the longer plots were curved in the hope of minimizing erosion of exposed soil on the slope and reducing the generally artificial appearance that is inevitable in the early years when adjacent restorations or reconstructions are being established. Pathway strips between most plots provided undisturbed areas for existing native species.

Plots were permanently marked using 1-inch diameter reinforcing bars cut to 24-inch lengths. A 1-inch brass tag with the plot number was bolted near the top end of each rebar. The rebar with the appropriate number was driven into the ground at the southwest corner of each plot (fig. 3). The tops of the steel markers were driven to ground level. Individual plots can be located using the prepared map and, if necessary, a metal detector.

Plot 19 remains as a control; there was no disturbance or direct seeding of this plot. Some native species from other plots are appearing there because of natural dispersal. Plot 20 is the part of the field containing the shallow ditch, and it remains largely undisturbed as well, although several wet-mesic species have been introduced. Nomenclature follows Mohlenbrock (1986).

Soil Preparation

Before restoration work started, the principal grasses in the field were *Poa pratensis* (Kentucky bluegrass), *Bromus inermis* (Hungarian brome), *Phleum pratense* (timothy), and *Agropyron repens* (quack grass). Frequent adventive forbs were *Daucus carota* (wild carrot), *Leucanthemum vulgare* (ox-eye daisy), *Asclepias syriaca* (common milkweed), *Aster pilosus* (hairy aster), *Achillea millefolium* (yarrow), and *Cirsium arvense* (Canada thistle). Surviving native species were often found in scattered, low-density populations.

Several preparation techniques were used, ranging from no soil disturbance to moldboard plowing. In the fall of 1973, Plot 1 (about 24 × 90 feet) was prepared by hand spading 48 3-foot square quadrats. Existing sod strips between the tilled quadrats were not disturbed. The following spring these quadrats were hand tilled several times and seeded on 20 June. The results were not satisfactory. Although germination was fair, the surrounding alien grasses, especially *Agropyron repens* and *Bromus inermis*, rapidly encroached. The introduced native species, including *Andropogon gerardii*, *Monarda fistulosa* (bergamot), and *Silphium*

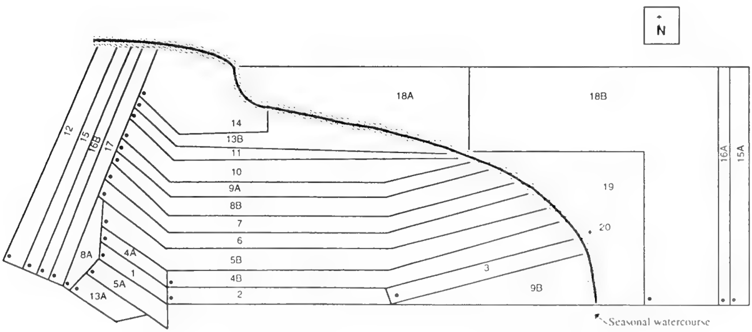

FIG. 3. Map of restoration area with individually numbered plots. • = Locations of buried steel identification markers

terebinthinaceum (prairie dock), have gradually increased. However, even now, Plot 1 continues to have significant populations of alien species.

This method of soil preparation was not repeated, and for several years a moldboard plow was used. In the fall, the next plot would be plowed to a depth of seven to ten inches. During the following spring the plot was tilled several times with a disk and a spring-toothed harrow. Thus a fine particulate seedbed was prepared and the existing vegetation removed. Seeding was followed by light harrowing. A roller was then used to create a firm seedbed. Seeding dates ranged from 18 May to 20 June. In thirteen of the seventeen years in which new plots were established the planting date fell within the last ten days of May or the first ten days of June. In spite of repeated tillage and late planting, competition from annual weeds was invariably severe. Typical weed growth the first year included *Amaranthus hybridus* (green amaranth), *Chenopodium album* (lamb's quarters), *Erigeron annuus* (annual fleabane), and *Panicum capillare* (witch grass). One method of attempting to reduce competition was to leave a plot fallow for an extra growing season. It was fall plowed and then disked several times the following year. The second spring following plowing it was disked, harrowed, and seeded. This procedure was followed on two plots, 7 and 14. Weed competition continued to be intense. Although each tillage operation destroyed growing weeds, it also created conditions that encouraged germination of additional existing seed. Leaving the soil without a cover for an additional year increased the already existing risk of erosion associated with moldboard plowing. That is what occurred, especially on the 1980 Plot 7 where movement of soil was significant. With weed competition seemingly not diminished and erosion increased, this method of leaving a plot fallow was rejected.

TABLE 1. Planting years and individual plot sizes.

Plot #	Year	Area (sq. ft.)	Area (acres)
1	1974	1,925	0.044
2	1975	8,026	0.184
3	1976	6,256	0.144
4A	1977	2,230	0.051
4B	1977	12,166	0.279
5A	1978	3,384	0.078
5B	1978	18,222	0.418
6	1979	13,164	0.302
7	1980	12,520	0.287
8A	1981	3,524	0.081
8B	1981	13,678	0.314
9A	1981	10,194	0.234
9B	1981	1,243	0.258
10	1982	11,660	0.268
11	1983	7,266	0.167
12	1984	7,366	0.169
13A	1985	2,486	0.057
13B	1985	8,784	0.202
14	1986	2,729	0.292
15A	1987	9,415	0.216
15B	1987	6,311	0.145
16A	1988	4,519	0.104
16B	1988	6,095	0.140
17	1989	6,748	0.155
18A	1990	20,548	0.472
18B	1990	59,904	1.375
19	control	20,301	0.466
20	control	17,672	0.406
Total		318,338	7.308

Use of the moldboard plow was discontinued after 1982. Fall tillage on Plot 12 was with a Soil Saver farm implement, which is a combination of disk blades and chisel plow. This thoroughly agitates the soil but does not invert a layer as with the moldboard plow. The additional plant material remaining on the surface over the winter reduced soil erosion. Before spring seeding began, the plot was disked and harrowed. Weed competition was similar to previous years, but reduced erosion and other satisfactory results encouraged continued use of this procedure.

In 1986 another system was tried. There was no fall tillage and in May a 2% solution of the glyphosate herbicide Roundup was sprayed on the plot. Use of a hand sprayer permitted directing the spray to avoid any existing native species. Approximately two weeks later this procedure was repeated to destroy vegetation previously missed. Immediately before and after hand seeding, the plot was lightly harrowed and then rolled. This method delayed and seemed to reduce weed competition, and erosion was virtually eliminated. Germination and growth of native species occurred, with results similar to those achieved with other procedures. Although this method required application of a herbicide, it proved useful for establishing prairie.

Seed

Seed was used for plant propagation, with a few recorded exceptions. Collection sites were all Illinois locations within approximately 120 miles of the restoration field. Seed was sown on the restoration site by hand broadcasting.

Freshly collected seed was dried indoors by spreading it in a shallow layer that was regularly turned. No artificial heat or forced air drying was used. Storage of the dried seed was in a cool, dry basement. Seed of species for which there were small collections was frequently stored in refrigerators. Also, damp stratification was occasionally used, but insufficient refrigerated storage made this procedure impractical on any large scale.

Seed from spring-flowering taxa was often planted in late summer. After drying, the seed of species such as *Dodecatheon meadia* (shooting star), *Pedicularis canadensis* (wood betony), *Phlox pilosa* (prairie phlox), and *Sisyrinchium albidum* (common blue-eyed grass) was planted in established restoration plots. Small open areas were selected, and the soil was agitated with a pronged hand cultivator. Seed was scattered on the surface, the soil was agitated again, and then compressed. It was felt that this method was more conserving of seed than broadcast application when establishing a new plot in which heavy weed competition was assured. However, spring seeding on new sites with *D. meadia* proved successful on Plots 2, 3, 4A, and 5B. The same was true for *Pedicularis canadensis* on Plot 12.

For about the first ten years of the project, legume seeds of the genera *Amorpha*, *Baptisia*, and *Dalea* were treated immediately before planting with an appropriate *Rhizobium* inoculant from Nitragin Corp. Before inoculation, *Amorpha canescens* (lead plant), *Baptisia lactea* (white wild indigo), and *Baptisia leucophaea* (cream wild indigo) were scarified using a vibrating bench sander.

Dalea candida (white prairie clover), *Dalea purpurea* (purple prairie clover), and *Baptisia lactea* germinated well, usually appearing the first or second year after planting. *Amorpha canescens* often, though not always, required several years to appear. In Plot 12, established in 1984, *A. canescens* emerged the first year; seedlings also appeared in 1990.

In recent years scarification was continued, but legume seed was no longer treated with inoculant. The appearance of increasing numbers of native legumes may suggest that the required strains of *Rhizobium* are established in the soil. Other legumes such as *Astragalus canadensis* (Canadian milk vetch) and *Lespedeza capitata* (round-headed bush clover) were planted without inoculation or scarification. They have become established in several locations within the restoration.

Nursery

Cultivated nursery plots were in continuous use for the duration of the restoration project. They provided a source of additional seed and transplants for species for which small amounts of seed were collected or for species that proved difficult or slow to establish by direct seeding in the field. Short nursery rows were seeded, and resulting plants were increased primarily by division.

A typical example is *Dodecatheon meadia*. Although seed germination was often satisfactory, this plant required four or more years to reach anthesis in the restoration field. Plot 3 first produced flowering individuals in 1984, eight years after seeding. A nursery row was seeded to hasten the process. After about three years, the nursery plants were lifted in late summer. The root system of *D. meadia* consists of a central root crown from which project numerous radiating roots. These roots, each of which has a bud, may be detached separately from the central crown. These single roots were planted in additional rows. This reduced the time necessary to produce mature plants, saving probably two years over starting from seed.

With an increase in the length and number of nursery rows, some divided roots and mature plants were transplanted to the restoration. This provided older plants for recently established plots, and thus the opportunity for earlier appearance of seedling plants surrounding the parents. A useful indication of success on a restoration is the appearance of second-generation plants. This has occurred on several plots with *Dodecatheon meadia*. In addition, the nursery rows produced increasing amounts of readily collected seed. In 1991, 12 ounces of *D. meadia* seed were harvested from 147 feet of nursery rows.

Sporobolus heterolepis (prairie dropseed) is an example of a species for which only small amounts of hand-collected seed were available initially, and there was no success in establishing the species on the restoration by direct seeding. Seed planted in a nursery row in 1981 had poor germination, but did provide a few plants. After two years these plants were lifted before the start of spring growth. Tillers were divided and immediately planted in an extension of that row. This was repeated in subsequent years, and after several rows were established the tufts were divided, and some were planted in the field in early spring. Except in excessively dry years, these transplants grew well. During the same time, the rows of *S. heterolepis*

in the nursery provided increasing amounts of seed. In 1986 the collection was 1.25 pounds, but by 1990, 13.5 pounds were harvested from 410 feet of nursery rows. This seed was sown on the restoration, and *S. heterolepis* is now appearing on the most recent restoration plots. Previous lack of substantial amounts of seed may have been the principal reason for the early failure to establish this grass by direct seeding.

Asclepias tuberosa ssp. *interior* (butterfly milkweed) is an example where, after establishment in the nursery, it became possible to collect more seed and at an optimal time of maturity. In earlier years there were only isolated instances of success from direct seeding. However, many young plants are appearing in recent plots on which the greater amounts of fully ripened seed were applied from the nursery.

When moisture conditions were adequate, transplanting most species from the nursery was successful, and anthesis was achieved in the first or second year. With some species, though, the transplants had a shortened life span. This was true of at least some transplants of *Echinacea pallida* (pale purple coneflower), *Liatris pycnostachya* (prairie blazing star), and *Liatris spicata* (marsh blazing star). The transplants grew and produced seed, and seedling plants were often found in the area. However, the parent plants frequently diminished in size and disappeared after three to five years. Determination was not made whether this was due to the transplantation.

Since 1981 the nursery has been located in part of the restoration field (Plot 8A). When it is no longer required, tillage of rows will cease, and existing plants will remain as a part of the restoration.

Fire

Annual late winter burning of the restoration site is a principal management technique. The ground cover retained over winter aids in prevention of erosion and provides shelter for wildlife. Prescribed burning usually has taken place in March. However, the dates have ranged from 25 February to 19 April. The April dates were due to prolonged snow cover in 1978 and wet field conditions in 1979. In the latter year there was some damage to emerging *Dodecatheon meadia*.

Fire lanes are mowed in late summer on the east, southeast, and southwest sides of the restoration where there is a risk of escape. When possible, the burn takes place when there is a westerly wind. This diverts the considerable amount of smoke away from the village. Backfires are started on the east side. Then the fire is permitted to run downwind from the west. Following these precautions, problems were never encountered. However, the startling height of flames and noise of the fire caused local citizens to notify the fire department on three occasions.

Removal of surface plant material from the previous season is especially helpful when attempting to establish early spring forbs. Rotational burning of nearby railroad prairie remnants has repeatedly shown reduced flowering of species such as *Dodecatheon meadia* and *Pedicularis canadensis* in years when burning did not occur. The only year when burning of the restoration field did not take place was 1989, because of the stress of the previous drought year and the reduced amount of thatch. There followed a marked decrease in flowering of early spring species.

Burning was often incomplete on plots during the first two or three years because of the difficulty of starting the fire in the coarse annual weeds. *Chenopodium album*, *Erigeron annuus*, *Amaranthus hybridus*, *Ambrosia artemisiifolia* (common ragweed), and *Ambrosia trifida* (giant ragweed) produced heavy stems and small amounts of leaf material, which prevented clean burns. Some plots had a heavy first-year growth of *Panicum capillare* and *Panicum dichotomiflorum* (fall panicum), which provided excellent fuel. In these plots prairie species seemed to establish themselves more quickly.

Weed Control

Annual weedy species grew vigorously on all plots during their first year of restoration. Removal of existing vegetation, combined with soil disturbance, permitted pioneering taxa to thrive. Considering that perennial sod cover had been in place, one could not fail to be impressed with the opportunistic character of these species. Their seed was necessarily present in the soil for an extended time, remaining dormant until proper conditions for germination occurred. The predominant pioneering species varied with location. Plots toward the south side of the field had more *Chenopodium album*, *Amaranthus hybridus*, *Ambrosia* spp., and *Erigeron annuus*. Farther north the overwhelmingly dominant species the first year was *Panicum capillare*.

In some years a weed mower was used on new plots in midsummer, cutting to about six inches high. However, if growth was heavy, this could cause accumulation of cut plant material on the native

seedlings, with resultant losses. Unless the growth was light or raking was possible, mowing was counterproductive.

In spite of their rapid coverage of a new restoration plot, these annual weeds never proved to be an enduring problem. Another wave of unwanted taxa replaced them during the second and third years. These included *Daucus carota* (wild carrot). This biennial had invaded the entire field before restoration, and by midsummer it was the dominant forb cover. It was expected to be the cause of substantial difficulty in restoration management. At times it became so pervasive that intervention seemed necessary. After flowering, the plants were mowed. This was largely ineffective since secondary umbels developed and additional mowing was contraindicated because of the presence of young prairie taxa. However, the concern proved unnecessary. *D. carota* remains present in the field, in greatest numbers on more recently planted plots. In established areas only small scattered specimens can be found, and these do not flower. Given enough time, *D. carota* will probably be virtually extirpated from the site through successional replacement.

Other biennial aliens in this second wave of succession were *Melilotus alba* (white sweet clover) and *Melilotus officinalis* (yellow sweet clover). Their growth appears to respond favorably to burning, and they continue to persist even in some older plots. Their populations vary from year to year, but have not shown a significant increase. If they are not succeeded, some form of intervention will be required. Hand removal by hoeing before anthesis is one choice. Another possible treatment is use of a sponge or wick applicator to apply concentrated (50%) glyphosate herbicide.

The aggressive rhizomatous growth of *Agropyron repens* makes it a tenacious invader from border areas. There have been instances of it overwhelming and replacing seedling prairie forbs, and it continues to be a problem in limited areas. However, native species replace *A. repens* in the long term. This process could be hastened by using more native tall grasses in the seed mix in a problem area. *Andropogon gerardii* has shown that it will displace *Agropyron repens*.

Cirsium arvense has a long history as an aggressive and persistent perennial weed in our agricultural areas, and it was expected to be a continuing problem on the restoration. Herbicide was used on denser stands, but as the prairie grasses became established, *C. arvense* was displaced. None has been observed in the restoration for several years.

A neighboring field provides a continuing seed source for *Rosa multiflora* (multiflora rose). Fire is only a partially effective control. Spot treatment with a 2% Roundup spray in early summer or midsummer will destroy existing plants; however, an annual sweep of the field is necessary to treat newly established individuals.

The tree seedlings that occur are *Fraxinus* sp. (ash), *Crataegus* sp. (hawthorn), *Ulmus pumila* (Siberian elm), and *Morus alba* (white mulberry). They are primarily in evidence in recently established plots. Once the prairie develops to the extent that adequate fuel is produced, fire becomes an effective control. Although the nearby village and a wood lot act as continuing seed sources, these trees have not presented a problem on the restoration.

SUCCESSIONAL CHANGES

Lack of understanding of species succession has caused unnecessary concern for the long-term species content of several plots. In 1975 the central portion of Plot 2 received a generous application of *Elymus canadensis* (Canada wild rye) in the seed mix. It flourished, and many individuals achieved anthesis the first year. For three years it continued to expand and dominate its range. Although it is a desirable prairie species, it is not a dominant in native prairie; thus, control of its range seemed necessary. Collection of *E. canadensis* seed was sharply curtailed and only small amounts were applied to subsequent plots. In Plot 2, thinly scattered *Andropogon gerardii* became more vigorous. By 1980 it had, to a large extent, displaced the *E. canadensis*. By 1990 only occasional plants of *E. canadensis* remained in the plot, which now also contains *Dodecatheon meadia*, *Eupatorium altissimum* (tall boneset), *Monarda fistulosa*, *Pycnanthemum pilosum* (hairy mountain mint), *Silphium laciniatum* (compass plant), and *Solidago juncea* (early goldenrod). *Elymus canadensis* proved to be a pioneering prairie species that creates a useful early cover and does not prevent later establishment of a diverse prairie community.

Rudbeckia hirta (black-eyed Susan) becomes established rapidly and often flowers the year it is seeded. Frequently it is used to provide some readily visible sense of success in otherwise weedy restorations or reconstructions. It also is an active participant in the mechanism of plant succession among prairie species. One of several examples where it became quickly dominant in the restoration was on the west end of Plot 2. It was replaced by even greater numbers of

Ratibida pinnata (yellow coneflower), another readily established species. By 1989 the *R. pinnata* population had decreased in that area, having been replaced by *Andropogon gerardii* and other native forbs.

Problems in establishing some species were predictable. *Lithospermum incisum* (fringed puccoon) and *Coreopsis lanceolata* (sand coreopsis) were readily grown in a nursery setting; however, after transplantation to the field, they disappeared within two years. These dry species were unable to survive the vigorous competition in a mesic soil environment. The same may be true of *Bouteloua curtipendula* (side-oats grama). Although it grows well when directly seeded onto plots, sometimes reaching anthesis the first year, it has disappeared in earlier plots, and population numbers are decreasing in recent seedings.

The drought of 1988 had prolonged effects on certain species. *Pedicularis canadensis* flowered normally that spring, but was decimated by the ensuing heat and drought. In 1989 there was no flowering, and no mature plants could be found. However, many seedling plants did appear. They increased in number and size the following year, but it was not until 1991 that flowering resumed in numbers comparable to those before the drought. A similar effect was noted with *Gentianella quinquefolia* ssp. *occidentalis* (stiff gentian), which did not flower between the years 1987 and 1993.

A warm-season grass that quickly became predominant in some plots was *Sorghastrum nutans* (Indian grass). One of several examples was in Plot 6, planted in 1979. In 1981 it was the dominant grass in that plot with only occasional *Andropogon gerardii* observed. Gradually there has been a population shift, so that ten years later the frequency of appearance of the two species has reversed. This may be a normal succession for this locality. Nearby railroad and cemetery prairie remnants have *A. gerardii* as the dominant tall grass with *S. nutans* scattered or absent. In high-quality prairie remnants, native forbs can partially displace *A. gerardii*. There are preliminary indications of that process occurring, and continued change in that direction is anticipated over time on the restoration.

FLORISTIC COMPOSITION AND EVALUATION

In 1991 and 1992, a survey of the flowering plants growing on the site yielded 189 species. Of these, 138 species are considered native to central Illinois. The remaining 51 species are alien plants, generally common in the region. The native species comprise 71 previously existing on the site and 67 established during the restoration project. The total number of families recorded was 37. Those with the greatest native representations are Compositae with 35 species, Gramineae 19, Cyperaceae 14, and Leguminosae 12.

A plant list is included at the end of this paper, containing the following information: whether the species is considered native or alien; plots where the species has been observed growing (although not necessarily limited to those plots); whether the species existed on the site or was introduced as part of the restoration; and seed source locations.

An attempt was made to evaluate the restoration inventory. The Swink-Wilhelm method of floristic quality assessment revised by Swink and Wilhelm (1994) was used with revised numerical ratings (Taft et al. 1993).

A combination of recent species introductions and rapid successional change contributes to an artificiality of community structure in a restoration of short duration, and in such a diverse assemblage, some taxa negate the effects of others on the index. Thus high-quality marginally established prairie species are, to some extent, negated by alien species that are merely transitional. With a floristic quality index of 44, the restoration presents significant native character; however, the primary use of the evaluation here is to act as a guide for future species improvement of the site.

The last plots were added to the restoration in 1990. Further plans include enrichment of existing plots, a quantitative vegetation analysis, and continued observation of successional changes. In the past, lack of seed was a deterrent to increasing the size of the restoration. With an established seed source now on the site, the opportunity for enlargement is enhanced.

In September 1995 the restoration qualified for and was included in the Illinois Natural Areas Inventory as a Category V (natural community restoration site).

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GARDNER PRAIRIE RESTORATION KEMPTON, ILLINOIS (FORD COUNTY)

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations[1]
A	Achillea millefolium	yarrow	various	N	
A	Agropyron repens	quack grass	various	N	
A	Agrostis alba	red top	18B,19,20	N	
N	Allium canadense	wild onion	20	N	
N	Allium cernuum	nodding wild onion	18A	Y	T,9
A	Amaranthus hybridus	green amaranth	8A,13A	N	
N	Ambrosia artemisiifolia	common ragweed	most	N	
N	Ambrosia trifida	giant ragweed	most	N	
N	Amorpha canescens	lead plant	3,4,5B,7,8B–12	Y	3,6,11,16
N	Andropogon gerardii	big bluestem	most	Y	2,6,11,12
N	Anemone canadensis	meadow anemone	1	Y	12
N	Anemone cylindrica	thimbleweed	613	Y	6,12,13
N	Antennaria neglecta	pussytoes	18B,19	N	
N	Apios americana	groundnut	8A	Y	T,6
A	Arctium minus	common burdock	20	N	
N	Aristida oligantha	prairie three-awn	19	N	
N	Asclepias sullivantii	prairie milkweed	16A,18B,19	N	
N	Asclepias syriaca	common milkweed	various	N	
N	Asclepias tuberosa ssp. interior	butterfly milkweed	2,6,8A,10–14	Y	1
N	Asclepias verticillata	whorled milkweed	various	N	
A	Asparagus officinalis	asparagus	12,19,20	N	
N	Aster ericoides	heath aster	various	N	
N	Aster laevis	smooth blue aster	10,12,17	Y	3
N	Aster novae-angliae	New England aster	7,9,8B,12,18B	Y	6,12
N	Aster pilosus	hairy aster	most	N	
N	Aster praealtus	willow aster	20	N	
N	Astragalus canadensis	Canadian milk vetch	10,13A,15	Y	14
N	Baptisia lactea	white wild indigo	various	Y	14
N	Baptisia leucophaea	cream wild indigo	8A	Y	1
N	Bidens frondosa	common beggar's ticks	20	N	
N	Bouteloua curtipendula	side-oats grama	15	Y	11
A	Brassica rapa	field mustard	various	N	
A	Bromus inermis	Hungarian brome	various	N	
N	Calamagrostis canadensis	blue joint grass	20	Y	6
N	Calystegia sepium	hedge bindweed	10,11,20	N	
N	Carex bebbii		15A	N	
N	Carex bicknellii	prairie sedge	16B	Y	T,9
N	Carex blanda		15A	N	
N	Carex brevior		17,20	N	
N	Carex gravida		15A	N	
A	Carex hirta *		12	N	
N	Carex meadii	Mead's sedge	1,12	N	
N	Carex molesta		15	N	
N	Carex muhlenbergii		15	N	
N	Carex vulpinoidea		15A	N	
N	Cassia fasciculata	partridge pea	18B,19	N	
A	Cerastium vulgatum	mouse-ear chickweed	20	N	
A	Chenopodium album	lamb's quarters	8A,13A	N	
A	Cichorium intybus	chicory	12,19,18B	N	
N	Cirsium discolor	pasture thistle	12,19,20	N	

[1] Listed at the end of this table.

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations
N	Coreopsis palmata	prairie coreopsis	5B,6,11,12	Y	6,11,13
N	Coreopsis tripteris	tall coreopsis	8A,18A,18B	Y	13,16
N	Cyperus esculentus	nut grass	20	N	
A	Dactylis glomerata	orchard grass	various	N	
N	Dalea candida	white prairie clover	3,4,6,7,11–15	Y	3,6
N	Dalea purpurea	purple prairie clover	3,6–8,10–15	Y	3,6,12–14
A	Daucus carota	wild carrot	most	N	
N	Desmanthes illinoensis	Illinois mimosa	8A	Y	17
N	Desmodium canadense	showy tick trefoil	16A	Y	
N	Dichanthelium acuminatum	panic grass	19	N	
N	Dodecatheon meadia	shooting star	2–7,12	Y	6,11
N	Echinacea pallida	pale purple coneflower	7,10–13	Y	6,10,11
N	Echinacea purpurea	purple coneflower	11	Y	7
A	Echinochloa crus-galli	barnyard grass	15A,20	N	
N	Eleocharis elliptica compressa	flat-stemmed spike rush	19,20	N	
N	Eleocharis verrucosa	slender spike rush	18B,19	N	
N	Elymus canadensis	Canada wild rye	various	Y	Several
N	Elymus virginicus	Virginia wild rye	20	N	
N	Erigeron annuus	annual fleabane	various	N	
N	Eryngium yuccifolium	rattlesnake master	various	Y	6,12,13
A	Erysimum cheiranthoides	wormseed mustard	20	N	
N	Eupatorium altissimum	tall boneset	various	N	
A	Festuca pratensis	meadow fescue	20	N	
N	Filipendula rubra	queen-of-the-prairie	8A,20	Y	T,15
N	Fragaria virginiana	wild strawberry	various	N	
N	Galium aparine	cleavers	20	N	
N	Galium boreale	northern bedstraw	8A	Y	T,9
N	Gentiana andrewsii	closed gentian	8A,8B	Y	5
N	Gentiana puberulenta	downy gentian	10	Y	6,16
N	Gentianella quinquefolia ssp. occidentalis	stiff gentian	11	Y	6,11
N	Geum laciniatum	rough avens	20	N	
N	Helianthus grosseserratus	sawtooth sunflower	20	N	
N	Helianthus rigidus	prairie sunflower	10	N	
N	Heliopsis helianthoides	false sunflower	7	N	
N	Heuchera richardsonii var. grayana	prairie alum root	8A	Y	11
N	Hierochloë odorata	vanilla grass	8A,16B	Y	T,9
A	Hordeum jubatum	squirrel-tail grass	20	N	
A	Ipomoea hederacea	ivy-leaved morning glory	15A	N	
N	Iris shrevei	blue flag	20	Y	T,5
N	Juncus dudleyi	Dudley's rush	17	N	
N	Juncus interior	interior rush	19	N	
N	Koeleria macrantha	June grass	8A	Y	T,9
A	Lactuca serriola	prickly lettuce	19	N	
N	Leersia oryzoides	rice cutgrass	15A,20	N	
A	Leonurus cardiaca	motherwort	20	N	
A	Lepidium campestre	field cress	20	N	
N	Lespedeza capitata	round-headed bush clover	3,4,6,13A,14	Y	1,3,6,12
A	Leucanthemum vulgare	ox-eye daisy	various	N	
N	Liatris aspera	rough blazing star	9–14,19	Y	6,10–13
N	Liatris pycnostachya	prairie blazing star	10,13	Y	2,6,12,13
N	Liatris spicata	marsh blazing star	10,11,13A,19	Y	7
N	Lithospermum canescens	hoary puccoon	1,5A,8A	Y	6
A	Lychnis alba	white campion	15A	N	
N	Lysimachia lanceolata	lance-leaved loosestrife	8A	Y	T,6
A	Medicago lupulina	black medick	20	N	

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations
A	Melilotus alba	white sweet clover	5B,6,12,18B,19	N	
A	Melilotus officinalis	yellow sweet clover	14	N	
A	Mollugo verticillatus	carpet weed	8A,13A	N	
N	Monarda fistulosa	wild bergamot	various	N	
N	Oenothera biennis	common evening primrose	various	N	
N	Oenothera pilosella	prairie sundrops	8A,12	Y	T,6
A	Ornithogalum umbellatum	star of Bethlehem	20	N	
N	Oxalis stricta	yellow wood sorrel	various	N	
N	Oxalis violacea	violet wood sorrel	16B	Y	T,14
N	Panicum capillare	witch grass	8A,18A	N	
N	Panicum dichotomiflorum	fall panicum	15A	N	
N	Panicum virgatum	switch grass	4A	Y	6
N	Parthenium integrifolium	wild quinine	various	Y	3,6,12,13
N	Parthenocissus inserta	Virginia creeper	19	N	
A	Pastinaca sativa	wild parsnip	various	N	
N	Pedicularis canadensis	wood betony	7,8,10–13	Y	6,11
N	Perideridia americana	perideridia	5B	N	
A	Phleum pratense	timothy	most	N	
N	Phlox pilosa	prairie phlox	12	Y	6
N	Physalis heterophylla	clammy ground cherry	11	N	
N	Physalis subglabrata	smooth ground cherry	18A	N	
N	Physostegia virginiana	false dragonhead	9,12,13A	Y	6,11,13
A	Plantago lanceolata	buckhorn	various	N	
A	Plantago rugelii	red-stalked plantain	various	N	
A	Poa compressa	Canada bluegrass	15A,20	N	
A	Poa pratensis	Kentucky bluegrass	most	N	
N	Polygala sanguinea	field milkwort	19	N	
N	Polygala verticillata	whorled milkwort	19	N	
A	Polygonum persicaria	lady's thumb	20	N	
A	Portulaca oleracea	purslane	8A	N	
A	Potentilla recta	sulfur cinquefoil	most	N	
N	Potentilla simplex	common cinquefoil	various	N	
N	Prunella vulgaris var. elongata	self-heal	18B,19	N	
N	Psoralea onobrychis	French grass	8A,20	Y	14
N	Pycnanthemum pilosum	hairy mountain mint	2,4B,10,11	Y	12
N	Pycnanthemum tenuifolium	slender mountain mint	18B	Y	
N	Pycnanthemum virginianum	common mountain mint	10	Y	3,6,11,12
N	Ranunculus abortivus	small-flowered buttercup	20	N	
N	Ratibida pinnata	yellow coneflower	various	N	
N	Rorippa islandica	marsh yellow cress	15A,20	N	
N	Rosa carolina	pasture rose	19	N	
A	Rosa multiflora	multiflora rose	16A,18B,19,20	N	
N	Rudbeckia hirta	black-eyed Susan	various	Y	6,12,13
N	Rudbeckia subtomentosa	fragrant coneflower	15A	N	
A	Rumex crispus	curly dock	various	N	
N	Schizachyrium scoparium	little bluestem	7,8B,9A,10,12	Y	3,6,10,12
N	Scirpus atrovirens	dark green rush	15A,20	N	
N	Scirpus pendulus	red bulrush	20	N	
N	Senecio plattensis	prairie ragwort	16B	N	
N	Silphium integrifolium	rosin weed	13	N	
N	Silphium laciniatum	compass plant	2,12,14–17	N	
N	Silphium perfoliatum	cup plant	8A,20	Y	T,4
N	Silphium terebinthinaceum	prairie dock	1,4A,4B	Y	12
N	Sisyrinchium albidum	common blue-eyed grass	8,10–13	Y	6,11
N	Smilacina stellata	starry false Solomon's seal	8A,20	Y	T,8
A	Solanum carolinense	horse nettle	various	N	

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations
A	Solanum dulcamara	bittersweet nightshade	20	N	
N	Solidago canadensis	tall goldenrod	2,4B,6	N	
N	Solidago juncea	early goldenrod	2,15A	N	
N	Solidago ptarmicoides	stiff aster	10	Y	
N	Solidago rigida	rigid goldenrod	2,7,8B,9,10	N	
A	Sonchus oleraceus	common sow thistle	8A,20	N	
N	Sorghastrum nutans	Indian grass	various	Y	12,14
N	Spartina pectinata	prairie cord grass	220	Y	6
N	Sporobolus asper	rough dropseed	16A	N	
N	Sporobolus heterolepis	prairie dropseed	8A,16A,16B	Y	3
A	Stellaria media	common chickweed	20	N	
N	Stipa spartea	porcupine grass	16A	Y	6,12,13
A	Taraxacum officinale	common dandelion	various	N	
N	Thalictrum dasycarpum	purple meadowrue	8A,20	Y	T,6
A	Thlaspi arvense	penny cress	20	N	
N	Tradescantia ohiensis	common spiderwort	4A,12,20	N	
A	Tragopogon pratensis	common goat's beard	12	N	
A	Tridens flavus	purple-top	19	N	
A	Trifolium hybridum	alsike clover	17,20	N	
A	Trifolium pratense	red clover	various	N	
A	Trifolium repens	white clover	17	N	
N	Typha latifolia	common cat-tail	20	N	
N	Verbena urticifolia	white vervain	15A	N	
N	Veronicastrum virginicum	Culver's root	6,7,12,13A	Y	6,11,13
N	Viola pedatifida	prairie violet	6,8A	Y	6
N	Viola pratincola	common blue violet	20	N	
N	Vitis aestivalis	summer grape	12,18B,19,20	N	
N	Zizia aurea	golden Alexanders	8A,17	Y	6,13

* Gardner (1992)

SEED SOURCE LOCATIONS

Location #	Site	County
1	Bath Township, central part Section 14	Mason
2	Bath Township, central part Section 4	Mason
3	Broughton Township Cemetery, Section 14 Broughton Township	Livingston
4	Broughton Township, ditch, Section 14	Livingston
5	Havana Township, roadside ditch, Section 26	Mason
6	Kempton, railroad 2 miles north to 2 miles south	Ford, Livingston
7	Lincoln Memorial Garden, Springfield, probable Lee County source	Sangamon
8	Mona Township, north roadside, Section 9	Ford
9	Natural Garden Nursery, St. Charles	Kane
10	North Quiver Township, Section 6	Mason
11	Crane Creek Township, Sections 26 and 36	Mason
12	Railroads and roadsides	Mason
13	Sheldon to Donovan, railroad	Iroquois
14	Swing Grove Cemetery, Section 6 Mason City Township South	Mason
15	Lafayette Home Nursery, Lee County source	Lee
16	Weston Cemetery, Yates Township, Section 2	McLean
17	Illinois State Tree Nursery, Quiver Township SE Section 33	Mason
T	Indicates introduction was by transplant rather than seeding	

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Vegetation Analysis of a Prairie Restoration Ford County, Illinois

Don Gardner[1]

ABSTRACT: A floristic survey was conducted on a 2.8 ha prairie restoration in northern Ford County, Illinois, from 1991 to 1994. This inventory yielded 138 native and 51 alien species in 37 vascular plant families (Gardner 1995). In 1993 a vegetation analysis of the site was initiated using the point-intercept technique, yielding 71 species of vascular plants. The three principal families recorded were Gramineae, Compositae, and Leguminosae. Taxa with the highest importance values were *Andropogon gerardii* (big bluestem) and *Aster pilosus* (hairy aster). Comparisons were made with an unrestored control area in which *Poa pratensis* (Kentucky bluegrass) and *Daucus carota* (wild carrot) had the highest importance values.

Introduction

Prairie restoration was started in 1974, and continued with annual preparation and seeding of successive small plots in a former pasture located in northern Ford County on the south margin of the village of Kempton, Illinois. The final plots were added to the restoration in 1990. The site lies within the Grand Prairie Section of the Grand Prairie Division in the natural divisions of Illinois (Schwegman et al. 1973). The soils are Swygert and Bryce, somewhat poorly drained, fine-textured silty clay loams (Fehrenbacher 1990). The topography is gently rolling with an elevation difference of about 4.5 meters between the high and low portions of the field. Most of the land in the immediate area is cultivated. Principal crops are corn and soybeans. Because of the presence of indigenous native species, the project is described as a restoration rather than a reconstruction. A floristic survey of the field was made from 1991 to 1994, and a plant list of 189 vascular species was compiled. This list comprises 67 native species introduced during the period of restoration, 71 native species indigenous to the site, and 51 alien species. Plant specimen vouchers were filed at the Illinois Natural History Survey herbarium (ILLS) in Champaign. A report was prepared that included the plant list. Certain details of restoration methods employed and results achieved during the prolonged restoration period were discussed by Gardner (1995).

As the next step in the study, a vascular vegetation analysis was conducted in June 1993. The purpose was to quantify the species' density, frequency, and cover in the restoration field. More significantly, a baseline was established for comparison with vegetation analyses to be performed in future years.

Methods

Five line transects totaling 315 meters were established in the restoration area in June 1993 (fig. 1). Vegetation along these transects was identified and recorded using a point-intercept method (Mueller-Dombois and Ellenberg 1974). This method was modified by using five holes spaced at 20 cm intervals in the horizontal portion of the point-intercept frame, which was supported about one meter above ground level by four folding legs. A pointed steel rod, 3.4 mm in diameter, was passed successively through each hole. Each plant contacted by the point during descent of the rod was recorded by species. Upon completion of the five intercept readings, the frame was moved along the line transect and the process repeated at 1.5 meter intervals. The total number of point-intercept locations was 1,050.

The measurement of cover by point-intercept has been considered to be the most accurate quantitative analysis of nonforest communities for description purposes (Becker and Crockett 1973; Mueller-Dombois and Ellenberg 1974). A disadvantage is that this method is difficult to implement under windy conditions. Wind moves the vegetation and prevents accurate readings beneath the descending point. Early mornings and evenings are often the best times for the work. Heavy accumulations of old vegetation can present another hindrance. Ease of sampling is enhanced by conducting the analysis in a year when the site has been burned during late winter, although this can limit the scope of the study.

A control area, Plot 19 (fig. 1), of 0.18 ha was reserved where no taxa were introduced. The same management techniques were used on the control and

[1] 3584 N 1300 East Road, Kempton, IL 60946

the restoration area. Annual burning was done in late winter or early spring. In the control area, readings were made at 110 point-intercept locations.

Determinations were made of relative density, relative frequency, and relative cover as described by Mueller-Dombois and Ellenberg (1974) and further clarified by Cox (1990). Relative density *(RD)* is computed by dividing the number of intercepted individual stems of a species *(I)* by the total number of individual stems intercepted of all species *(TI)* and multiplying by 100, $RD = (I/TI) \times 100$. Relative frequency *(RF)* is an expression of the number of points at which a species occurs *(F)*, divided by the points of occurrence for all species *(TF)*, and then converted to a percentage, $RF = (F/TF) \times 100$. Thus density is a count of the individual stems intercepted by the descending point. Frequency is an expression of the distribution of the species over the extent of the transects. For example, a high density number indicates only that many individual stems of that species are present. There is no indication from this of how evenly they are distributed. A low frequency number for that species would suggest that the species is concentrated in one or more clusters and is not evenly distributed over the site.

Relative cover *(RC)* is sometimes described as relative dominance. In this analysis, it is a proportional measure of species present at the highest stratum of areal vegetation cover and reflects the visual aspect of the unit. It is determined by recording the first intercept encountered at each point. The total of these intercepts *(FI)* for each species is divided by the total intercept points *(TIP)* and is expressed as a percentage, $RC = (FI/TIP) \times 100$. Species ranking high in *RC* would be the most apparent species when scanning the site under survey.

The sum of relative density and relative frequency gives the importance value *(IV)* for each species out of a total of 200, $IV = RD + RF$. Relative cover, as measured by this point-intercept method, gives a bias against species positioned at lower strata. For this study, cover is recorded to provide information about the aspect and appearance of the site. Thus only relative density and relative frequency are used to compute *IV*. Importance value is useful in providing a means for combining the recorded counts for purposes of ranking. Absolute values provide the most important quantitative measures. With relative values, a species can appear to increase or decrease without actually changing in recorded numbers. Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

Readings were taken at 940 intercept points on the restoration portion of the study site. The total number of individual plants intercepted was 1,888 (table 1). These represented 71 species, of which 66.2% were natives. The three principal families encountered were Compositae, Gramineae, and Leguminosae. Of the species encountered on the control, 48.5% were natives (table 2). Several native species not previously observed on the control site are now appearing there. It is reasonable to assume that there has been a natural

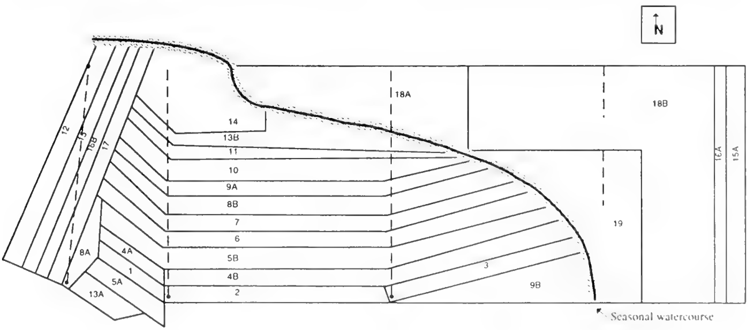

Fig. 1. Restoration field (2.8 ha), Kempton, Illinois. Numbered areas indicate consecutively restored plots (1974–1990). Unrestored control is Plot 19 (shaded). Locations of point-intercept transects (---).

dispersion of native species from the restored area. These species are not found on land adjacent to the restoration site, and they were not artificially introduced into the control. They include *Andropogon gerardii, Elymus canadensis* (Canada wild rye), *Liatris aspera* (rough blazing star), *Liatris pycnostachya* (prairie blazing star), and *Sorghastrum nutans* (Indian grass).

Of all the species in the restored plots, *Andropogon gerardii* ranked highest, with a relative density of 27.9%, relative frequency of 23.5%, and relative cover of 35.5%. Three of the six most important species were native grasses that were added to the restoration by seeding; their combined *IV* was 71.8 (table l). This reinforces personal observation of disturbed prairie sites where native grasses tend to dominate during middle stages of prairie development.

The second-ranking species on the restoration transects was *Aster pilosus*, a weedy native forb previously established on the site. *Daucus carota* and *Achillea millefolium* (Yarrow) also ranked among the top six species. These aliens were also well established on the field before the start of restoration work. The difference in abundance on the restoration and control for the two species is readily observable and is confirmed by a comparison of relative cover values. In the control, *D. carota* has a 10.9% relative cover and *A. millefolium* 3.6%. On the restoration these values are 2.7% and 2.8% respectively.

Although lower in rank, planted native prairie forbs appeared among the highest thirty species in *IV* on the restoration transects. Among these are *Pedicularis canadensis* (wood betony), *Amorpha canescens* (lead plant), *Zizia aurea* (golden Alexanders), and *Baptisia lactea* (white wild indigo). Changes in their ranking in future vegetation analyses of the site will be of particular interest.

On the pre-restoration field two of the principal grasses were *Poa pratensis* and *Phleum pratense* (timothy). This is reflected on the control, where they have high importance values of 33.3 and 16.9 respectively. On the restoration they are being displaced and have *IV*s of 6.2 and 3.8 (tables 1 and 2).

CONCLUSION

When working with a restoration there is justifiable satisfaction in observing the establishment and increase of native species. However, this is often accompanied by a subjectivity that assigns a greater prevalence to these species than they merit. A quantitative survey counters this tendency. There has been encouraging progress in establishing this restoration with a diversity of species. On the restoration there was a 69.3% rate of encounter of individual native plants, while on the control the rate was only 35.8% (tables 1 and 2). This analysis, however, provides an emphatic reminder that restoration of prairie is, even with some degree of management, a ponderously slow process. Of the ten species ranking highest in *IV* on the restoration, five are alien in origin.

Empirical observation indicates that plants in recently established prairies are in a state of rapid species population change. By performing periodic vegetation analyses, these changes can be quantified. Numerous prairies are being restored or reconstructed throughout the Midwest. If these survive, there is the hope that on many of them, plant surveys and vegetation analyses will be conducted. Such information can provide valuable base line records for use by succeeding generations of botanists, ecologists, and prairie enthusiasts.

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TABLE 1. Point-intercept Data, Restoration Area.

Family	Species	Importance value (IV 200)	Intercept count individuals	Relative density (%)	Total intercept points	Relative frequency (%)	First intercept	Relative cover (%)
GRAMINEAE	Andropogon gerardii	51.4	526	27.9	380	23.5	334	35.5
COMPOSITAE	Aster pilosus	16.5	148	7.8	140	8.7	76	8.1
UMBELLIFERAE	Daucus carota	11.7	103	5.5	101	6.3	25	2.7
COMPOSITAE	Achillea millefolium	11.5	102	5.4	98	6.1	26	2.8
GRAMINEAE	Sorghastrum nutans	10.6	103	5.5	83	5.1	65	6.9
GRAMINEAE	Schizachyrium scoparium	9.8	97	5.1	76	4.7	42	4.5
GRAMINEAE	Poa pratensis	6.2	55	2.9	53	3.3	27	2.9
COMPOSITAE	Ambrosia artemisiifolia	6.0	52	2.8	52	3.2	13	1.4
LEGUMINOSAE	Trifolium pratense	5.7	53	2.8	46	2.8	21	2.2
ROSACEAE	Potentilla recta	4.6	41	2.2	39	2.4	17	1.8
COMPOSITAE	Ratibida pinnata	4.6	43	2.3	37	2.3	17	1.8
LEGUMINOSAE	Medicago lupulina	4.4	39	2.1	38	2.4	7	0.7
LABIATAE	Monarda fistulosa	3.9	40	2.1	28	1.7	25	2.7
GRAMINEAE	Phleum pratense	3.8	35	1.9	31	1.9	19	2.0
COMPOSITAE	Aster ericoides	3.5	33	1.7	29	1.8	20	2.1
COMPOSITAE	Helianthus rigidus	2.8	27	1.4	22	1.4	18	1.9
SCROPHULARIACEAE	Pedicularis canadensis	2.7	25	1.3	23	1.4	4	0.4
GRAMINEAE	Bromus inermis	2.6	24	1.3	22	1.4	12	1.3
LEGUMINOSAE	Melilotus alba	2.6	24	1.3	22	1.4	11	1.2
JUNCACEAE	Juncus interior	2.0	17	0.9	17	1.1	8	0.9
GRAMINEAE	Elymus canadensis	1.9	17	0.9	16	1.0	13	1.4
GRAMINEAE	Agropyron repens	1.8	16	0.8	16	1.0	8	0.9
ROSACEAE	Fragaria virginiana	1.8	16	0.8	16	1.0	3	0.3
CYPERACEAE	Carex hirta *	1.8	18	1.0	14	0.9	2	0.2
LEGUMINOSAE	Amorpha canescens	1.5	15	0.8	12	0.7	6	0.6
UMBELLIFERAE	Zizia aurea	1.5	15	0.8	12	0.7	7	0.7
CYPERACEAE	Carex brevior	1.5	13	0.7	13	0.8	3	0.3
LEGUMINOSAE	Baptisia lactea	1.4	12	0.6	12	0.7	8	0.9
COMPOSITAE	Taraxacum officinale	1.4	12	0.6	12	0.7	2	0.2
UMBELLIFERAE	Pastinaca sativa	1.3	11	0.6	11	0.7	3	0.3
CONVOLVULACEAE	Calystegia sepium	1.0	9	0.5	9	0.6	5	0.5
COMPOSITAE	Leucanthemum vulgare	0.9	8	0.4	8	0.5	5	0.5
PLANTAGINACEAE	Plantago lanceolata	0.9	8	0.4	8	0.5	5	0.5
COMPOSITAE	Echinacea pallida	0.9	9	0.5	7	0.4	4	0.4
LEGUMINOSAE	Dalea candida	0.9	8	0.4	7	0.4	6	0.6
GRAMINEAE	Agrostis alba	0.8	7	0.4	7	0.4	5	0.5
UMBELLIFERAE	Eryngium yuccifolium	0.8	7	0.4	7	0.4	3	0.3
COMPOSITAE	Parthenium integrifolium	0.8	7	0.4	7	0.4	4	0.4
COMPOSITAE	Silphium laciniatum	0.7	7	0.4	5	0.3	5	0.5
GRAMINEAE	Poa compressa	0.6	6	0.3	5	0.3	4	0.4
LABIATAE	Prunella vulgaris var. elongata	0.6	6	0.3	5	0.3	2	0.2
LEGUMINOSAE	Dalea purpurea	0.6	5	0.3	5	0.3	3	0.3
PLANTAGINACEAE	Plantago rugelii	0.6	5	0.3	5	0.3	0	0.0
ASCLEPIADACEAE	Asclepias verticillata	0.5	5	0.3	4	0.2	2	0.2
COMPOSITAE	Solidago rigida	0.5	5	0.3	4	0.2	4	0.4
ASCLEPIADACEAE	Asclepias tuberosa ssp. interior	0.5	4	0.2	4	0.2	0	0.0
COMPOSITAE	Erigeron annuus	0.5	4	0.2	4	0.2	3	0.3
PRIMULACEAE	Dodecatheon meadia	0.3	3	0.2	3	0.2	0	0.0
COMPOSITAE	Eupatorium altissimum	0.3	3	0.2	3	0.2	1	0.1
SOLANACEAE	Solanum carolinense	0.3	3	0.2	3	0.2	0	0.0
GRAMINEAE	Dactylis glomerata	0.3	3	0.2	2	0.1	2	0.2
ONAGRACEAE	Oenothera biennis	0.3	3	0.2	2	0.1	1	0.1
COMPOSITAE	Rudbeckia hirta	0.3	3	0.2	2	0.1	1	0.1
COMPOSITAE	Ambrosia trifida	0.2	2	0.1	2	0.1	1	0.1
ASCLEPIADACEAE	Asclepias syriaca	0.2	2	0.1	2	0.1	1	0.1
LILIACEAE	Asparagus officinalis	0.2	2	0.1	2	0.1	1	0.1
CYPERACEAE	Carex vulpinoidea	0.2	2	0.1	2	0.1	1	0.1
COMPOSITAE	Coreopsis palmata	0.2	2	0.1	2	0.1	2	0.2
COMPOSITAE	Echinacea purpurea	0.2	2	0.1	2	0.1	2	0.2
OXALIDACEAE	Oxalis stricta	0.2	2	0.1	2	0.1	1	0.1
COMPOSITAE	Sonchus oleraceus	0.2	2	0.1	2	0.1	1	0.1
LEGUMINOSAE	Trifolium repens	0.2	2	0.1	2	0.1	0	0.0
VIOLACEAE	Viola pratincola	0.2	2	0.1	2	0.1	0	0.0
COMPOSITAE	Aster novae-angliae	0.1	1	0.1	1	0.1	0	0.0
LEGUMINOSAE	Lespedeza capitata	0.1	1	0.1	1	0.1	1	0.1

Family	Species	Importance value (IV 200)	Intercept count individuals	Relative density (%)	Total intercept points	Relative frequency (%)	First intercept	Relative cover (%)
COMPOSITAE	Liatris pycnostachya	0.1	1	0.1	1	0.1	1	0.1
LEGUMINOSAE	Melilotus officinalis	0.1	1	0.1	1	0.1	1	0.1
ONAGRACEAE	Oenothera pilosella	0.1	1	0.1	1	0.1	0	0.0
LABIATAE	Physostegia virginiana	0.1	1	0.1	1	0.1	1	0.1
ROSACEAE	Potentilla simplex	0.1	1	0.1	1	0.1	0	0.0
SCROPHULARIACEAE	Veronicastrum virginicum	0.1	1	0.1	1	0.1	1	0.1
	Absence of cover	0.0					18	1.9
	Total	200	1888	100.0	1615	100.0	940	100.0

	SUMMARY	
	Species count	71
	Native species	66.2%
	Individual native intercepts	1308
	Native species intercepts	69.3%

* Gardner (1992)

TABLE 2. Point-intercept Data, Control Plot.

Family	Species	Importance value (IV 200)	Intercept count individuals	Relative density (%)	Total intercept points	Relative frequency (%)	First intercept	Relative Cover (%)
GRAMINEAE	Poa pratensis	33.3	31	16.6	30	16.8	24	21.8
UMBELLIFERAE	Daucus carota	29.5	28	15	26	14.5	12	10.9
GRAMINEAE	Phleum pratense	16.9	16	8.6	15	8.4	8	7.3
COMPOSITAE	Aster pilosus	16.4	15	8.0	15	8.4	10	9.1
COMPOSITAE	Achillea millefolium	10.9	10	5.3	10	5.6	4	3.6
GRAMINEAE	Dichanthelium acuminatum	10.9	10	5.3	10	5.6	9	8.2
CRUCIFERAE	Brassica rapa	8.7	8	4.3	8	4.5	4	3.6
COMPOSITAE	Antennaria neglecta	7.7	7	3.7	7	3.9	1	0.9
COMPOSITAE	Ambrosia artemisiifolia	6.6	6	3.2	6	3.4	3	2.7
ROSACEAE	Potentilla recta	5.5	5	2.7	5	2.8	4	3.6
PLANTAGINACEAE	Plantago lanceolata	4.9	5	2.7	4	2.2	3	2.7
GRAMINEAE	Andropogon gerardii	4.4	4	2.1	4	2.2	4	3.6
ROSACEAE	Fragaria virginiana	4.4	4	2.1	4	2.2	2	1.8
GRAMINEAE	Agropyron repens	3.8	4	2.1	3	1.7	1	0.9
COMPOSITAE	Ratibida pinnata	3.8	4	2.1	3	1.7	1	0.9
GRAMINEAE	Sorghastrum nutans	3.8	4	2.1	3	1.7	1	0.9
CYPERACEAE	Carex brevior	3.3	3	1.6	3	1.7	3	2.7
UMBELLIFERAE	Pastinaca sativa	3.3	3	1.6	3	1.7	2	1.8
COMPOSITAE	Aster ericoides	2.2	2	1.1	2	1.1	2	1.8
GRAMINEAE	Bromus inermis	2.2	2	1.1	2	1.1	1	0.9
CYPERACEAE	Carex vulpinoidea	2.2	2	1.1	2	1.1	2	1.8
GRAMINEAE	Elymus canadensis	2.2	2	1.1	2	1.1	2	1.8
LEGUMINOSAE	Medicago lupulina	2.2	2	1.1	2	1.1	0	0.0
AMARANTHACEAE	Amaranthus hybridus	1.1	1	0.5	1	0.6	0	0.0
ASCLEPIADACEAE	Asclepias syriaca	1.1	1	0.5	1	0.6	1	0.9
CHENOPODIACEAE	Chenopodium album	1.1	1	0.5	1	0.6	1	0.9
COMPOSITAE	Eupatorium altissimum	1.1	1	0.5	1	0.6	1	0.9
JUNCACEAE	Juncus interior	1.1	1	0.5	1	0.6	1	0.9
LEGUMINOSAE	Melilotus officinalis	1.1	1	0.5	1	0.6	1	0.9
GRAMINEAE	Poa compressa	1.1	1	0.5	1	0.6	1	0.9
POLYGONACEAE	Polygonum persicaria	1.1	1	0.5	1	0.6	0	0.0
LABIATAE	Prunella vulgaris var. elongata	1.1	1	0.5	1	0.6	0	0.0
POLYGONACEAE	Rumex crispus	1.1	1	0.5	1	0.6	1	0.9
	Total	200	187	100.0	179	100.0	110	100.0

	SUMMARY	
	Species count	33
	Native species	48.5%
	Individual native intercepts	67

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EFFECTS OF DIFFERENT FIRE REGIMES ON THE GROUND LAYER VEGETATION OF A DRY SAND SAVANNA, HOOPER BRANCH NATURE PRESERVE, IROQUOIS COUNTY, ILLINOIS

Kenneth C. Johnson[1] and John E. Ebinger[2]

ABSTRACT: A ground layer vegetation study was undertaken in the fall of 1989 in a dry sand savanna at the Hooper Branch Nature Preserve. Sections of this sand savanna had been subjected to different fire regimes, one site burned every spring from 1987 through 1989, the other site burned only in the spring of 1987. At both sites *Carex pensylvanica* Lam. (common oak sedge) had the highest relative frequency. The site with the three-year burn regime had a higher density of woody stems, in particular *Rhus copallina* L. var. *latifolia* Engl. (winged sumac) and *Rosa carolina* L. (pasture rose); however, the less frequent burning regime allowed for the presence of woody species not found at the site with three consecutive burns, in particular, seedlings of *Quercus velutina* Lam. (black oak). The less frequent burning may also have contributed to a higher relative frequency of some herbaceous species.

INTRODUCTION

Savannas occurred across much of Midwestern North America at the time of European settlement (Nuzzo 1986). These communities consisted of open-grown trees, mostly oaks, in small groves or as scattered individuals with a herbaceous, primarily graminoid, understory. These savannas were found throughout much of what is now Illinois, forming broad to narrow ecotones separating forest from prairie, or appearing as isolated communities within the prairie. These oak savannas in Illinois are separated into three subclasses: black soil savannas on the fine-textured soils of glacial till plains; sand savannas on sandy, acidic soils; and barrens on excessively drained, acidic soils (Madany 1981; Packard 1991).

We believe that black soil savannas were once extremely common in Illinois. Most have been destroyed, the majority having been converted to farmland, the remainder degraded by fire suppression. In contrast, sand savannas, though restricted to localized areas of sand outwash plains and old lake deposits, are still relatively common. Two major sand areas occur in Illinois (Schwegman et al. 1973). One is the Illinois River and Mississippi River Sand Area Division with extensive sand deposits in Mason County and scattered smaller deposits along the rivers. The presettlement forests in this division were studied by Rodgers and Anderson (1979); Adams and Anderson (1980) and later Jenkins et al. (1991) examined the present forest structure and composition. The second sand area is the Kankakee Sand Area Section of the Grand Prairie Division in Kankakee and Iroquois counties in the northeastern part of the state. Hedborn (1984) reported on the presettlement vegetation of parts of this section, and McDowell et al. (1983) and later Johnson and Ebinger (1992) studied the present-day forests.

The regular fires that swept across the prairie peninsula restricted the encroachment of woodlands and were a major factor in the maintenance of prairie and savanna communities (McClain and Elzinga 1994). The suppression of fire in the postsettlement period has changed many oak savanna communities into closed forests, often with a dense understory of shade-tolerant species and a depauperate ground layer (Gleason 1912, 1913; Transeau 1935; Curtis 1959; Vogl 1974; Ebinger and McClain 1991; Ladd 1991; Wilhelm 1991). Controlled burning is an integral part of the management to restore these savanna communities to their presettlement character. The present study was undertaken to determine the composition of the ground layer vegetation in a dry sand savanna community and to examine the effects of recent controlled burns on this community.

STUDY AREA

Hooper Branch Nature Preserve is located in the northeast corner of Iroquois County, Illinois (NW S13 T29N R11W), in the Kankakee Sand Area Section (Schwegman et al. 1973; Hedborn 1984). This 230 ha

[1] Rolling Oaks Farm, 40W693 McDonald Road, Elgin, IL 60123
[2] Botany Department, Eastern Illinois University, Charleston, IL 61920

tract of forest, savanna, prairie, and old-field communities was recognized as containing good quality dry sand savanna (White and Madany 1978). The land was acquired by the state of Illinois in 1984, and a 195 ha area was dedicated as a nature preserve in 1985. The area is situated at the edge of former glacial Lake Watseka, which was formed approximately 14,000 years ago (Willman and Frye 1970). With the incising of the Illinois River valley, this glacial lake was eventually drained, leaving sandy beaches and near-shore sand deposits. Wind action created the sand dunes and swales, upon which characteristic sand savanna and sand prairie vegetation was established (Glass 1985). The soil is classified as Plainfield fine sand, which is a light-colored, acidic sand derived from windblown sand deposits (Wascher et al. 1951). The study area, located within the sand savanna community at Hooper Branch Nature Preserve, is traversed by an east-west access road that divides it into two parts. Land management south of this access road (Site A) included annual controlled burns in the springs of 1987, 1988, and 1989; the land north of the access road (Site B) was subjected to a controlled burn only once, in the spring of 1987 (Glass, pers. comm.).

MATERIALS AND METHODS

The ground layer vegetation was sampled in September 1989, using five north-south transects 20 m long, located randomly, in both Site A and Site B. Along each transect, 0.25 m^2 quadrats were placed randomly at 1 m intervals, yielding a total of 100 plots for each site. A random-numbers table was used to determine the number of meters the quadrats were placed to the west (odd-numbered quadrats) or to the east (even-numbered quadrats) of the transect. All herbaceous species within the quadrats were identified, and their relative frequencies were calculated. In addition, the stems of all woody seedlings in the plots were counted, and their densities (stems/m^2), relative frequencies, relative densities, and importance values were calculated. A chi-square statistical procedure was used (2 × 2 contingency table using the Yates correction factor) to determine if the relative frequencies of the dominant species found at both sites were significantly different (Sokal and Rohlf 1981). Nomenclature follows Swink and Wilhelm (1994).

RESULTS AND DISCUSSION

Forty species were recorded in the plots, 26 from Site A and 33 from Site B, 19 of them common to both sites (table 1). *Carex pensylvanica* dominated both sites, in many areas forming a continuous groundcover under an open canopy of *Quercus velutina*. Of the 10 common species encountered (those with a combined relative frequency of ≥ 5.0 for the two sites), 4 species showed no significant difference in relative frequency between the two sites, and 6 species showed a significant difference (table 1).

TABLE 1. Relative frequencies of ground layer species sampled from Site A (3 burns) and Site B (1 burn) at the Hooper Branch Nature Preserve. χ^2 values are shown for the dominant species.

	Relative frequency		
Species	Site A	Site B	χ^2
Carex pensylvanica Lam.	35.1	23.7	16.25***
Rosa carolina L.	6.9	8.0	1.25
Euphorbia corollata L.	6.9	4.9	0.60
Rhus copallina L. var. *latifolia* Engl.	6.2	0.7	12.03***
Panicum villosissimum Nash var. *pseudopubescens* (Nash) Fern.	5.8	4.2	0.39
Eragrostis spectabilis (Pursh) Steud.	4.6	5.2	0.39
Koeleria cristata (L.) Pers.	3.9	7.8	4.17*
Andropogon scoparius Michx.	2.6	9.1	11.53***
Cassia fasciculata Michx.	1.2	6.6	11.48***
Quercus velutina Lam.	1.2	4.2	4.60*
Rumex acetosella L.	4.6	-	
Panicum virgatum L.	3.9	-	
Cassia nictitans L.	3.1	0.3	
Tephrosia virginiana (L.) Pers.	2.6	1.0	
Sporobolus cryptandrus (Torr.) A. Gray	2.3	-	
Liatris aspera Michx.	1.5	-	
Asclepias verticillata L.	1.2	2.8	
Lithospermum canescens (Michx.) Lehm.	1.2	0.8	
Commelina erecta L. var. *deamiana* Fern.	1.2	0.4	
Cyperus filiculmis Vahl	0.8	2.8	
Erigeron canadensis L.	0.8	0.3	
Monarda punctata L.	0.8	-	
Helianthemum canadense (L.) Michx.	0.4	1.8	
Rhus glabra L.	0.4	1.4	
Panicum oligosanthes Schult. var. *scribnerianum* (Nash) Fern.	-	5.6	
Andropogon gerardii Vitman	-	1.4	
Corylus americana Walter	-	1.0	
Achillea millefolium L.	-	1.0	
Prunus serotina Ehrh.	-	0.7	
Smilacina stellata (L.) Desf.	-	0.7	
Lespedeza capitata Michx.	-	0.7	
Rubus allegheniensis Porter	-	0.7	
Rubus flagellaris Willd.	-	0.7	
Amorpha canescens Pursh	-	0.3	
Others	0.8	1.2	
Total	100.0	100.0	

* $P < .05$., ** $P < .01$., *** $P < .001$.

The woody species encountered in the quadrats are listed in table 2, along with their densities, relative values, and importance values. Four species were recorded for Site A, with a total density of 3.58 stems/m^2. Nine species were encountered at Site B, with a total density of 2.64 stems/m^2. The stem densities of *Rhus copallina* var. *latifolia* and *Rosa carolina* were higher at Site A than at Site B. Kraege (1978) concluded that regular burning in a northern Illinois prairie stimulated the growth of *Rubus flagellaris* Willd. (common dewberry). Similarly, this may account for the higher stem density of *Rosa carolina* and *Rhus copallina* var. *latifolia* at Site A in the sand savanna. The more frequent burning is also probably responsible for the low seedling density of *Quercus velutina*. Similar results were obtained by Henderson and Long (1984) for seedling densities in black oak woodlands in northwestern Indiana.

Initially, there was some concern over any possible negative effects of prescribed burning at the Hooper Branch Nature Preserve. The savanna communities there have retained much of their natural character, yet have received only sporadic fires during the postsettlement period. In this short-term study it may be concluded that these recent prescribed burns have not adversely affected this sand savanna, except for the vigorous resprouting in some shrub species. It would be interesting to study the effects of this phenomenon on the ground layer species composition and the community structure over a longer time period. This sand savanna is an example of an intact and stable plant community that contains a diverse assemblage of native plant species. Short-term comparative studies at such high quality natural areas are unlikely to reveal any conclusive findings or patterns in land use practices. It is probable that only through long-term studies or monitoring can land management practices such as prescribed burning be accurately assessed.

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Table 2. Densities (stems/m^2), relative frequencies, relative densities, and importance values of the ground layer woody species sampled from Site A (3 burns) and Site B (1 burn) at the Hooper Branch Nature Preserve.

	Stems/m^2		Relative frequency		Relative density		Importance value	
Species	A	B	A	B	A	B	A	B
Rosa carolina	2.52	1.44	47.4	46.0	70.0	53.7	117.4	99.7
Rhus copallina latifolia	0.92	0.08	42.1	4.0	25.6	3.0	67.7	7.0
Quercus velutina	0.12	0.52	7.9	24.0	3.3	19.4	11.2	43.4
Rhus glabra	0.02	0.20	2.6	8.0	1.1	7.5	3.7	15.5
Corylus americana	-	0.12	-	4.0	-	4.5	-	8.5
Prunus serotina	-	0.12	-	4.0	-	4.5	-	8.5
Rubus allegheniensis	-	0.08	-	4.0	-	3.0	-	7.0
Rubus flagellaris	-	0.04	-	4.0	-	2.9	-	6.9
Amorpha canescens	-	0.04	-	2.0	-	1.5	-	3.5
Total	3.58	2.64	100.0	100.0	100.0	100.0	200.0	200.0

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FIFTY YEARS OF CHANGE IN ILLINOIS HILL PRAIRIES[1]

Kenneth R. Robertson[2], Mark W. Schwartz[3], Jeffrey W. Olson[2], Brian K. Dunphy[4], and H. David Clarke[5]

ABSTRACT: Hill prairies are islandlike patches of prairie vegetation occurring on otherwise wooded steep slopes that face south or southwest. In Illinois, hill prairies appear intermittently along most of the western border of the state formed by the Mississippi River and along the Illinois River from north of Peoria south to its junction with the Mississippi, with a few in east-central Illinois and other scattered localities. Illinois has four types of hill prairies: loess (by far the most abundant), glacial drift, gravel, and sand. The floras found on hill prairies are combinations of species that also occur in other types of prairies—dry, black soil, sand, and gravel. Only a few species are largely restricted to hill prairies. Hill prairies appear to be decreasing in size from the encroachment of woody species. Rates of area change for nine hill prairies were examined using a series of aerial photographs from approximately 1940 to 1988. On average, these hill prairies lost 63% of their area, became fragmented into smaller units, and experienced an increase in the ratio of edge to center. Field studies showed that there was a correlation between the proportion of area lost and lowered species richness.

INTRODUCTION

For nearly 30 years, Dr. Robert A. Evers of the Illinois Natural History Survey studied the hill prairies of Illinois. His landmark treatise *Hill Prairies of Illinois* was published in 1955. During the early 1970s, Dr. Evers revisited many of his earlier sites and took extensive notes with the aim of updating the 1955 publication. The update was never published, although the notes remain in files at the Illinois Natural History Survey. The senior author of the current paper was fortunate to accompany Dr. Evers during the late 1970s on several trips to Bland Hill Prairie in Greene County and Cap au Gris Hill Prairie in Calhoun County; this first sparked his interest in hill prairies.

Hill prairies are islandlike prairie openings occurring on steep slopes that are (or were) otherwise forested. This prairie vegetation usually occurs only on the slopes, not on the tops of hills, where a combination of factors results in droughty conditions, such as the south- to west-facing slope aspect, steep slope angle, dry prevailing winds, and well-drained soil. Measurements made of slopes at six hill prairies in Jersey County, Illinois, showed average slopes of 17.3% to 56.3% (Kilburn and Warren 1963).

According to Evers (1955), the term "hill prairies" was first used by A. G. Vestal in 1943 during his ecology classes and seminars at the University of Illinois; they have also been called bluff prairies, goat prairies, and prairie openings. Prior to European settlement, hill prairies likely never formed large continuous belts in Illinois, but were fragmented by forested ravines that dissect the river bluffs and slopes.

METHODS

As part of a project to investigate critical trends in the changing Illinois environment (Robertson and Schwartz 1994), aerial photos from 1938 to 1988 were used for nine loess hill prairies in Illinois to ascertain the loss of hill prairies during the last 50 years (table 1, fig. 1). The aerial extent of each hill prairie was digitized at three to five time periods into a Geographical Information System (GIS - ARC/INFO version 6.0, 1992, as implemented on SUN workstations). Aerial photographs were obtained from the archives of

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[2] Center for Biodiversity, Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, IL 61820

[3] Section of Plant Biology, Robbins Hall, University of California-Davis, Davis, CA 95616

[4] Michigan State University, East Lansing, MI 48824

[5] Department of Plant Biology, University of Illinois, Urbana, IL 61801

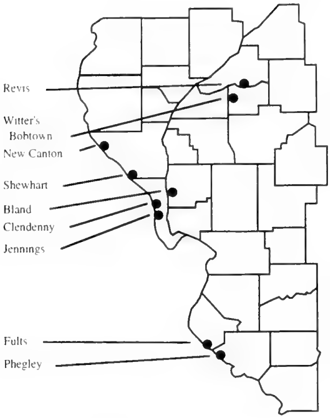

FIG. 1. Locations of the nine hill prairies sampled.

the University of Illinois Map Library. Photographs prior to 1988 were taken at a 1:20,000 scale by the U.S. Department of Agriculture Soil Conservation Service. The 1988 photographs had lower resolution than previous series, but the poorer resolution did not systematically bias the results. The Bobtown Hill Prairie photo coverage for 1988 was partially obscured by late afternoon shadows, making habitat identification very difficult; this photo was eliminated from the analysis.

To assess the relative amount of edge through which woody species may encroach upon each prairie, the perimeter to area (p/a) ratio was used. This value should be related to how fast areas may be invaded, other factors being equal. A simple geometric relationship is expected in the p/a ratio over time if the area is decreasing. To determine if the p/a ratio is increasing at rates faster than expected, a p/a ratio index was used, which is a measure of the p/a ratio relative to a circle of equal size. Since a circle has the minimum p/a ratio of any two-dimensional shape, this index will always be greater than 1.0. There is no maximum to the p/a ratio index; higher values indicate a more complex shape with increasing amounts of edge for a given area.

Each of the nine sites was also sampled for vegetation characteristics. Between one and ten permanent sampling transects were established at each site to sample for prairie species richness and woody species invasion (table 2). Transect ends were located at random intervals along the crests of hilltops, with each transect set out downslope from the crest at the steepest angle possible. Sampling stations were established at 5-meter intervals along transects from the crest to the lower edge of each hill prairie. At each sampling station a 25 m^2 plot was sampled for woody species. All woody stems within this plot were identified to species and counted. At the center of each 25 m^2 plot, a 1 m^2 quadrat was sampled for cover of all vegetation. Cover was estimated to the nearest percent. Summary data for sites were generated by the mean of all plots sampled at each hill prairie.

DISTRIBUTION OF HILL PRAIRIES

Hill prairies are found along certain river systems in the central United States. The largest number of hill prairies occur along the Mississippi River, or tributaries near their junctions with the Mississippi, from near St. Paul, Minnesota, and adjacent Wisconsin southward to Iowa and southern Illinois. In Minnesota, hill prairies occur in Fillmore, Goodhue, Houston, Wabasha, and Winona counties, south of Minneapolis. They are found mostly along tributaries that flow into the Mississippi River from the west, and they can be up to 8 miles from the Mississippi (Olson 1989). In most instances, hill prairies in Minnesota occur on southwest-facing slopes in thin soil atop bluffs that have a northwest to southeast orientation.

In Wisconsin, hill prairies are mostly found on steep south- to west-facing slopes above limestone, sandstone, or dolomite bluffs on the eastern side of the Mississippi River from Polk County southward to Grant County. There are Wisconsin state natural areas for hill prairies in Crawford, Grant, Pierce, and Vernon counties. Five-Mile Bluff Prairie Natural Area occurs on slopes above bluff tops in Pepin County along the Chippewa River approximately three miles from its junction with the Mississippi River (pers. comm. from Kelly Kearns and Eric Epstein, Wisconsin Department of Natural Resources). See Shimek (1924) for early photographs of hill prairies near Prairie du Chien, Wisconsin.

Hill prairies in Iowa can be found in both the eastern and western parts of the state (Cooper and Hunt 1982; White and Glenn-Lewin 1984; Rosburg et al. 1994). There are only a few in the northeastern "Driftless Area" of the state (Shimek 1910, 1924). More

TABLE 1. Changes in size and shape for nine Illinois hill prairies between about 1940 and 1988.

Site (county)	Ownership	Grazing and burning history	Date of photo	Area (ha²)	P/A ratio	P/A ratio index	No. of units	Proportion of original area
Bland (Greene)	Private	moderately grazed, not burned	1938	2.04	0.0351	1.42	1	1.000
			1968	1.12	0.0626	1.87	1	0.550
			1988	0.65	0.1211	2.76	1	0.319
Clendenny (Calhoun)	Private	moderately grazed, not burned	1940	3.97	0.0574	3.22	1	1.000
			1950	3.77	0.0689	3.77	1	0.949
			1968	3.45	0.0741	3.88	1	0.868
			1988	2.52	0.0807	3.61	1	0.633
Fults (Monroe)	State, Nature Preserve	not grazed, burned regularly since 1970s	1940	7.20	0.0625	4.73	2	1.000
			1950	7.22	0.0633	4.80	2	1.000
			1962	5.73	0.0785	5.30	6	0.797
			1988	3.35	0.1169	6.04	9	0.466
Jennings (Calhoun)	Private, Natural Heritage Landmark	no grazing for ca. 25 years, burning began in 1990s	1940	2.16	0.1081	4.48	1	1.000
			1950	1.65	0.1301	4.71	2	0.764
			1968	1.65	0.1068	3.87	3	0.765
			1988	0.99	0.1509	4.24	3	0.458
New Canton (Pike)	Private	probably not grazed, burning began in 1990s	1936	1.71	0.0944	3.48	3	1.000
			1939	1.83	0.1045	3.99	3	1.070
			1950	0.96	0.1270	3.51	8	0.563
			1968	1.53	0.1250	4.36	8	0.897
			1988	0.32	0.1246	1.99	2	0.212
Phegley (Randolph)	Private	intensively grazed, not burned	1940	2.65	0.0543	2.49	1	1.000
			1952	2.21	0.0615	2.58	2	0.834
			1959	2.04	0.0693	2.79	2	0.770
			1971	0.97	0.1455	4.04	8	0.365
			1988	0.46	0.1907	3.65	5	0.175
Shewhart (Pike)	Private	not recently grazed, not burned since at least 1928	1936	3.10	0.0665	3.30	3	1.000
			1939	1.61	0.0898	3.21	3	0.516
			1950	2.05	0.0840	3.39	4	0.662
			1968	2.22	0.0928	3.90	5	0.714
			1988	0.79	0.1572	3.94	7	0.254
Witter's Bobtown* (Menard)	Private, Nature Preserve	not grazed recently, burned regularly now, brush removed	1939	1.99	0.0300	1.19	1	1.000
			1950	1.17	0.0400	1.22	1	0.588
			1957	1.50	0.0346	1.20	1	0.752
			1969	1.31	0.0421	1.36	1	0.658
Revis (Mason)	State, Nature Preserve	not grazed recently, long history of fall burning, brush removed	1939	39.16	0.0410	7.24	15	1.000
			1950	34.26	0.0474	7.83	14	0.875
			1957	32.06	0.0558	8.91	16	0.819
			1969	32.51	0.0414	6.66	14	0.830
			1988	17.37	0.0813	9.56	22	0.444

*1988 photo obscured by evening shadows and eliminated from this analysis.

TABLE 2. Most frequently sampled plant species in nine Illinois hill prairies.

Species	Percent of plots	Average cover (% total area)
Schizachyrium scoparium	64.6	30.49
Bouteloua curtipendula	62.4	13.50
Petalostemum purpureum	37.1	3.41
Panicum spp.	29.8	2.68
Aster azureus	29.2	5.29
Andropogon gerardii	27.5	25.90
Psoralea tenuiflora	27.5	12.24
Solidago nemoralis	22.5	3.14
Melilotus alba	18.0	9.05
Aster ericoides	16.3	9.81
Senecio plattensis	16.3	0.37
Rhus glabra	15.7	27.60
Cornus drummondii	15.2	14.38
Euphorbia corollata	15.2	1.47
Ambrosia artemisiifolia	14.6	12.55
Cassia fasciculata	14.0	4.48
Eupatorium altissimum	13.5	2.74
Aster patens	12.9	2.47
Ruellia humilis	12.9	0.96
Juniperus virginiana	11.2	20.60
Kuhnia eupatorioides	10.7	2.57
Asclepias verticillata	10.7	2.12

than a dozen hill prairie remnants have been catalogued as "element occurrences" by the Iowa Department of Natural Resources (pers. comm. to J. Olson) in Allamakee, Clayton, Dubuque, Fayette, and Jackson counties; these are called "alkaline high prairies: Midwestern type." Some of these occur along the Mississippi River; others are along the Iowa River. At least one is found in Fayette County above a creek that flows into the Volga River.

Hill prairies also occur in the "Loess Hills" region along the Missouri River in northwestern Missouri, western Iowa, and southeastern South Dakota (Novacek 1985). In Missouri, Steyermark (1963) says that these prairies are best developed in Atchison and Holt counties, but extend southward into Jackson County, below Kansas City. Floristically, these prairies are quite different from hill prairies along the Mississippi River and nearby tributaries; many plant species from the Great Plains reach their easternmost limits of distribution in the loess hills.

In Illinois, hill prairies are scattered along the Mississippi River from near the Wisconsin border southward to the southern part of the state (Evers 1955); those currently listed on the Illinois Natural Areas Inventory (INAI) are shown in figure 2. In southern Illinois, there is some gradation from hill prairies to barrens and glades; see Heikens and Robertson (1994), Heikens, West, and Robertson (1994), and Robertson and Heikens (1994) for discussions of barrens in Illinois. Hill prairies also occur along the Illinois River from north of Peoria southward to its junction with the Mississippi River; additional hill prairies appear along the Sangamon River, a tributary of the Illinois River (Evers 1955). A few small hill prairies can be found in east-central Illinois along the Embarras River in Coles County; these were described by Vestal (1918), Reeves et al. (1978), and Ebinger (1981).

Field work conducted for the INAI during 1976–1977 located 446 hill prairies; only 127, many less than one acre in size, were relatively undisturbed by grazing (Nÿboer 1981) (fig. 3). A total of 534.4 acres of

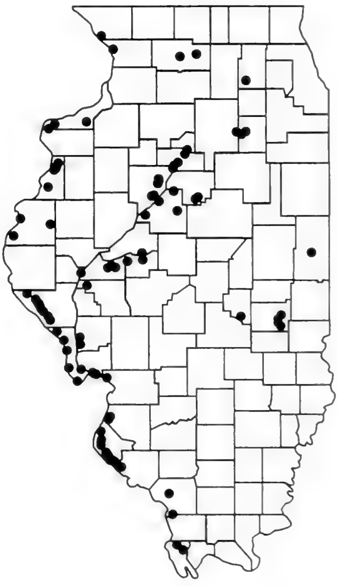

FIG. 2. Hill prairies on the Illinois Natural Areas Inventory as of November 1994

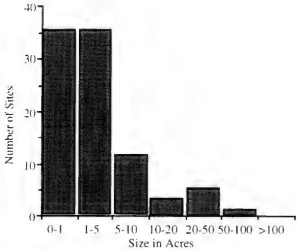

FIG. 3. Number of Grades A and B hill prairies, by acreage categories, as identified by the INAI (White 1978).

Grades A and B hill prairies were included in the inventory, representing four types of hill prairies: loess (463 acres), glacial drift (51.5 acres), gravel (14.7 acres), and sand (5.2 acres). Because of their steep slopes and relative inaccessibility, many hill prairies have not been plowed and converted to row crops. It is likely that a higher proportion of original hill prairie remains in Illinois than other prairie types. Thus, hill prairies represent some of the last living windows into the ecology of the prairie biome that dominated Illinois for 8,000 years.

TYPES OF HILL PRAIRIES

In Illinois, there are four basic types of hill prairies recognized by the INAI (White 1978): loess hill prairies, sand hill prairies, glacial drift hill prairies, and gravel hill prairies. The first, loess hill prairies, is the most abundant type in the state and occur primarily along the Mississippi and Illinois rivers. These prairies are named for their characteristic windblown loam soil, which was deposited as the glaciers receded (Pielou 1991). Two subclasses of loess hill prairies can be recognized—one occurring on loess deposited above bluffs and the other where the loess is deposited just above the floodplains of rivers, mostly on top of mounds of glacial till. Two examples of loess hill prairies above bluffs in the Illinois nature preserves system are Fults Hill Prairie and Pere Marquette nature preserves (only one small hill prairie is actually in the latter, but larger hill prairies are in the nearby Pere Marquette State Park). Examples of loess hill prairie nature preserves over glacial till include Meredosia Hill Prairie, Revis Hill Prairie, and Witter's Bobtown Hill Prairie. Large amounts of the latter type of loess hill prairie, most of it severely grazed, also occur at Site M in Cass County, recently purchased by the Illinois Department of Conservation.

Varying amounts of windblown sand can be mixed in with the loess, and pockets of sand can also be deposited on top of loess. Areas with extensive amounts of sand that support some characteristic sand prairie plants are considered to be sand hill prairies. Some examples are Hanover Bluff Nature Preserve, the Principia College Prairies (see Kilburn and Ford 1963; Kilburn and Warren 1963; Bland and Kilburn 1966; Ranft and Kilburn 1969), and French Woods Hill Prairie. Sand is also found to varying degrees at loess hill prairies, such as Revis Hill Prairie.

Glacial drift hill prairies occur on steeply sloping glacial till that does not have a mantle of loess. These are widely scattered in Illinois. Several occur along the Illinois River from just south of Peoria, north to Putnam, LaSalle, and Grundy counties. Examples in the nature preserve system include Crevecoeur, Ridgetop Hill Prairie, Robinson Park Hill Prairies, and Wier Hill Prairie. A few glacial drift hill prairies also occur in the extreme eastern part of Illinois. Windfall Prairie Nature Preserve in Vermilion County occurs on steep southwest-facing slopes above the Middle Fork of the Vermilion River. Calcareous seeps occur on the lower slopes of the prairie. Several small hill prairies are found in Coles County. These were first described by Vestal (1918) and subsequently studied by Reeves et al. (1978) and Ebinger (1981). Recently, Behnke and Ebinger (1989) described the invasion of one of these hill prairies by the non-native *Euonymus alatus* (winged wahoo, burning bush). According to J. E. Ebinger (pers. comm.), some plants frequently seen on these Coles County hill prairies, but not mentioned on the lists given below, are *Calystegia spithamaea* (dwarf bindweed), *Galium circaezans* var. *hypomalacum* (wild licorice), *Helianthus divaricatus* (woodland sunflower), *Lespedeza virginica* (slender bush clover), *Monarda bradburiana* (Bradbury beebalm), *Silphium terebinthinaceum* (prairie-dock), and *Thaspium barbinode* (hairy meadow parsnip). *Melilotus alba* (white sweet clover) is a common non-native species. None of these Coles County hill prairies are dedicated as an Illinois nature preserve; the poorest quality one is located in a city park, and the others are privately owned.

There are only a few gravel hill prairies in Illinois. There is some intergradation between "gravel hill prairies" and "gravel prairies" as recognized by the INAI. There are two nature preserves considered gravel hill prairies by the INAI. Beach Cemetery

Prairie in Ogle County is located on a gravel kame, and Manito Prairie in Tazewell County is located on a gravel and sand terrace above the floodplain of the Illinois River. Numerous other dry prairies occur on gravel kames and eskers in northern Illinois.

HILL PRAIRIE PLANTS

On 36 mostly loess Illinois hill prairies, Evers (1955) reported 252 taxa (248 species) of vascular plants. Most of these are native prairie species, but these figures also include a few native forest species and non-native species found in 18 or more sites. Of these 252 taxa, 123 occurred in 3 or fewer sites, while only 53 were found in 12 or more prairies. This relatively large number of species is due to the considerable ecological diversity that occurs on hill prairies in Illinois and the latitudinal difference of nearly 400 miles from the northernmost to the southernmost locations.

The most frequently occurring vascular plant species in hill prairies include *Schizachyrium scoparium* (little bluestem), *Bouteloua curtipendula* (side-oats grama), and *Erigeron strigosus* (daisy fleabane) (Anderson 1972; Evers 1955; Kilburn and Ford 1963). At Fults Hill Prairie, *Sorghastrum nutans* (Indian grass) and *Bouteloua curtipendula* had the highest percent of cover (Dziadyk 1978). The INAI lists the first two species plus *Sorghastrum nutans* as dominant plants on loess hill prairies, with the following listed as characteristic plants: *Asclepias viridiflora* (green milkweed), *Kuhnia eupatorioides* (false boneset), *Linum sulcatum* (wild flax), *Lithospermum incisum* (fringed puccoon), *Penstemon pallidus* (pale beardtongue), *Psoralea tenuiflora* (scurfy pea), *Sisyrinchium campestre* (blue-eyed-grass), and *Spiranthes magnicamporum* (scented ladies' tresses) (White 1978). Data are presented above (table 2) of our own sampling of nine loess hill prairies. The three most frequently occurring species were *Schizachyrium scoparium, Bouteloua curtipendula,* and *Petalostemum purpureum* (purple prairie clover); the three species with the largest percent cover were *Schizachyrium scoparium, Andropogon gerardii*, and *Rhus glabra* (smooth sumac).

Non-native plant species are generally less of a problem in hill prairies than in other types of prairies in Illinois. *Melilotus alba* is a serious problem in many hill prairies, as is *Robinia pseudoacacia* (black locust). Bush honeysuckles (*Lonicera maackii,* members of the *L. tatarica* complex, and *L.* × *bella*) are found on some hill prairies and have the potential to become serious woody invaders. *Belamcanda chinensis* (blackberry-lily), native to China and Japan, is a fairly frequent herbaceous plant on hill prairies, as are *Lespedeza stipulacea* (Korean clover) and *Verbascum thapsus* (woolly mullein). Some non-native grasses frequently observed on hill prairies include *Poa pratensis* (Kentucky bluegrass), *P. compressa* (Canadian bluegrass), *Bromus tectorum* (downy brome), *B. inermis* (smooth brome), and *Festuca elatior* (tall fescue). Woody non-native species sometimes seen on hill prairies are *Rosa multiflora* (multiflora rose), *Elaeagnus umbellata* (autumn olive), *Rhamnus cathartica* (common buckthorn), and *Maclura pomifera* (Osage orange). Behnke and Ebinger (1989) suggest that *Euonymus alatus* could be a major woody invader of hill prairies when a seed source occurs in the immediate area.

The floras of these islandlike xeric habitats are combinations of plant species that also occur in other types of dry prairies, black soil prairies, sand prairies, and gravel prairies, with only a few species largely restricted to hill prairies. It is always difficult to place individual species into categories, as there are nearly always exceptions to generalizations. The following groupings of plant species found on loess hill prairies are based on the authors' experiences in Illinois, taking into account discussions with John E. Ebinger, William E. McClain, Loy R. Phillippe, and John B. Taft (errors are ours, not theirs). We also compared species lists from Evers (1955) with species lists in Betz and Lamp (1989, 1992) and several unpublished species lists in the files of the Illinois Natural History Survey. The senior author would greatly appreciate any additions, corrections, or other comments from readers. Information on endangered and threatened species is from the Illinois Endangered Species Protection Board (1994).

Common on loess hill prairies, also frequent in various dry and mesic prairies:[6]

Amorpha canescens (lead plant)
Andropogon gerardii (big bluestem)
Anemone cylindrica (thimbleweed)
Asclepias verticillata (horsetail milkweed)

[6] Conspicuous by their general absence on hill prairies are these mesic prairie species: *Asclepias sullivantii* (Sullivant's milkweed), *A. tuberosa* (butterfly weed), *Baptisia leucantha* (white wild indigo), *B. leucophaea* (cream wild indigo), *Desmodium canadense* (showy tick trefoil), *Eryngium yuccifolium* (rattlesnake master), *Hypoxis hirsuta* (yellow star-grass), *Liatris pycnostachya* (prairie blazing star), *Parthenium integrifolium* (wild quinine), *Prenanthes aspera* (rough white lettuce), *Viola pedatifida* (prairie violet), and *Zizia aurea* (golden Alexanders). Three common mesic prairie grasses, *Panicum virgatum* (switch grass), *Sporobolus heterolepis* (prairie dropseed), and *Stipa spartea* (needle grass) rarely occur on hill prairies.

Aster azureus (sky-blue aster)
Aster ericoides (heath aster)
Bouteloua curtipendula (side-oats grama)
Cassia fasciculata (partridge pea)
Ceanothus americanus (New Jersey tea)
Comandra umbellata (false toadflax)
Coreopsis palmata (prairie coreopsis)
Coreopsis tripteris (tall tickseed)
Echinacea pallida (pale coneflower)
Elymus canadensis (nodding wild rye)
Erigeron strigosus (daisy fleabane)
Eupatorium altissimum (tall boneset)
Euphorbia corollata (flowering spurge)
Heuchera richardsonii (prairie alumroot)
Koeleria macrantha (June grass)
Kuhnia eupatorioides (false boneset)
Lespedeza capitata (round-headed bush clover)
Liatris aspera (rough blazing-star)
Linum sulcatum (wild flax)
Lithospermum canescens (hoary puccoon)
Lobelia spicata (spiked lobelia)
Monarda fistulosa (wild bergamot)
Oxalis violacea (purple oxalis)
Penstemon pallidus (pale beardtongue)
Petalostemum candidum (white prairie clover)
Petalostemum purpureum (purple prairie clover)
Physostegia virginiana (false dragonhead)
Pycnanthemum pilosum (hairy mountain mint)
Rosa carolina (pasture rose)
Ruellia humilis (wild petunia)
Schizachyrium scoparium (little bluestem)
Scutellaria parvula (small skullcap)
Silphium integrifolium (rosinweed)
Solidago nemoralis (field goldenrod)
Solidago rigida (rigid goldenrod)
Solidago speciosa (showy goldenrod)
Sorghastrum nutans (Indian grass)
Tradescantia ohiensis (spiderwort)
Verbena stricta (hoary vervain)

Mostly found on loess hill prairies and sand prairies:[7]

Agalinis skinneriana (pale false foxglove)
STATE THREATENED
Anemone caroliniana (Carolina anemone)
Asclepias amplexicaulis (sand milkweed)
Asclepias viridiflora (green milkweed), also gravel prairies
Aster oblongifolius (aromatic aster)
Aster sericeus (silky aster), also gravel prairies
Coreopsis lanceolata (tickseed coreopsis)
Desmodium sessilifolium (sessile-leaved tick trefoil)
Draba reptans (whitlow grass), also gravel prairies
Helianthus occidentalis (western sunflower), also gravel prairies
Heterotheca camporum (golden aster)
Liatris cylindracea (blazing-star), also gravel prairies
Opuntia macrorhiza (prickly-pear)
Panicum villosissimum (hairy panic grass)
Phlox bifida (cleft phlox)
Polygala incarnata (pink milkwort), also glades
STATE ENDANGERED
Polygala verticillata var. *isocycla* (whorled milkwort)
Sisyrinchium campestre (blue-eyed grass)
Solidago ptarmicoides (white goldenrod)

Mostly found on loess hill prairies and gravel prairies:

Lithospermum incisum (fringed puccoon)
Microseris cuspidata (prairie dandelion)
STATE ENDANGERED

Largely restricted to loess hill prairies in Illinois, although they can occur in different habitats in other states:

Asclepias stenophylla (narrow-leaved green milkweed)
STATE THREATENED
Buchnera americana (blue hearts)
Hedyotis nigricans (narrow-leaved bluets), also glades
Onosmodium occidentale (marbleseed)
Psoralea tenuiflora (scurfy pea)
Rudbeckia missouriensis (Missouri coneflower), also glades
STATE ENDANGERED
Solidago radula (rough goldenrod), also glades
Spiranthes magnicamporum (Great Plains ladies' tresses)

LOSS OF AREA

People have observed that hill prairies in Illinois have been decreasing in area, primarily because of the encroachment of woody species (Anderson 1972, 1991; Behnke and Ebinger 1989; Ebinger 1981; Kilburn and Warren 1963; McClain and Anderson 1990; Reeves et al. 1978; Werner 1994; White 1978). This observation was quantified at Pere Marquette State Park by McClain (1983), who found from an analysis of aerial photographs that five hill prairies had been reduced in size by an average of 62% between 1937 and 1974.

Robert A. Evers resurveyed most of the sites described in his 1955 publication *Hill Prairies of Illinois* during the early 1970s. In his unpublished notes in files at the Illinois Natural History Survey, Evers frequently commented that hill prairies seen in the 1950s were being invaded by woody species by the 1970s. For example, in 1955, Evers noted that prairie vegetation dominated Seehorn Cemetery Hill Prairie in Adams County. Notes made by Evers on 9 June 1970 said, "On this visit, prairie no longer occupied the cemetery. The cemetery has some large red cedars (6 dm dbh), a few other large trees, and a host of

[7]A few other typical sand prairie plants can occasionally be found in sand pockets on hill prairies, such as *Aster linariifolius* (flax-leaved aster), *Helianthemum bicknellii* (frostweed), *Monarda punctata* (horsemint), *Plantago purshii* (salt-and-pepper plant), *Selaginella rupestris* (rock spikemoss), *Talinum rugospermum* (flower-of-an-hour), *Tephrosia virginiana* (goat's-rue), and *Viola pedata* (bird's-foot violet).

saplings of *Ulmus, Quercus muhlenbergii, Carya* sp., *Morus rubra, Fraxinus americana* etc. The herb layer was also practically all forest species."

Several points can be observed by comparing figure 1 of Evers (1955), a map of the 100 hill prairies described or observed in the early 1950s, with figure 2 in the present publication, a map showing the locations of the 91 hill prairies currently on the Illinois Natural Areas Inventory. (1) Many of Evers' sites are still extant and are now on the INAI. (2) There are a number of sites now on the INAI that were not recorded by Evers. Loess hill prairies were the primary focus of Evers, and he did not visit many glacial till hill prairies. Also, some hill prairies have been discovered since Evers' work. (3) Many sites on Evers' map are not on the INAI. Some have been completely filled by forest species, as in the example of Seehorn Cemetery given above. Evers described nine hill prairies in Adams County, but none from this county are currently on the INAI. A few sites have been destroyed by quarrying. Other Evers' sites are probably still extant but are too small to include on the INAI. Lastly, Evers mentions that many of the hill prairies he visited were grazed, and even if those were still extant, they may not be of high enough quality to include on the INAI.

It is a matter for conjecture why hill prairies have not completely disappeared in the past 100 years. Prior to European settlement, Native Americans likely burned the hill prairies, perhaps to function as lookout points. Because hill prairies are high above the surrounding terrain, lightning is frequent, and it probably started natural wildfires. The first generations of European settlers probably burned hill prairies periodically; at any rate they did not stop wildfires. However, with the advent of the "Smokey the Bear" philosophy in the 1930s, hill prairies were no longer burned, and woody vegetation began encroaching upon the prairies.

Although the steep slopes of hill prairies precluded their conversion to row crops, hill prairies were likely used extensively for grazing domestic livestock. Both Evers (1955) and Nÿboer (1981) commented that grazing has deleterious effects on species composition in hill prairies. However, grazing probably kept many hill prairies open that would have otherwise reverted to forest. Hill prairies that have been grazed, such as Revis Hill Prairie Nature Preserve, have shown remarkable resiliency in eventually recovering much of their original quality. Perhaps 50 or more acres of hill prairies at Site M in Cass County, recently purchased by the Illinois Department of Conservation, have the potential of increasing in natural quality with proper management.

RESULTS

Over the approximately 50-year study interval, hill prairies were reduced in size by an average of 63.0% (table 1, fig. 4), ranging from 36.7% at Clendenny to 82.5% at Phegley. A careful examination of figure 4 shows that the rate of loss has not been uniform over time. Fults has been managed as a nature preserve with regular burning since the early 1970s, yet it still lost 33.1% of its 1940 area between 1962 and 1988. Revis, the largest unit in our study, has a history of intermittent fall burns since the early 1970s (Schwegman and McClain 1985), yet it decreased in size from 32.51 hectares in 1969 to 17.37 in 1988. Perimeter maps showing the loss of area over the study period for Bland and Phegley hill prairies are shown in figure 5. Although our sites do not evenly sample sites of varying size, there was no indication of a relationship between the size of a site at the beginning of the study interval and rate of habitat loss.

In addition to losing significant area, our results show that hill prairies are becoming more fragmented; two-thirds of the sites increased the number of units or patches of hill prairie at some point during the study interval (table 1). This is graphically demonstrated for Phegley in figure 5. In the case of New Canton and Phegley, the number of patches is currently decreasing as small isolated units are completely filled in by woody vegetation (table 1).

The perimeter to area *ratio* shows an average increase of over 100% during the study interval (fig. 6). Not only are our hill prairies declining from woody invasion at an alarming rate, but the propensity for this woody invasion is accelerating because of an increased ratio of edge to center of the habitat. As any two-dimensional object shrinks in size, the ratio of edge to center will increase. The p/a ratio *index* assesses the amount of edge present in a hill prairie patch relative to a circle of equal area. This p/a ratio index does not show dramatic increases over the study interval at most sites (fig. 7), although the p/a ratio index was higher in 1988 than at the beginning of the series in seven of the nine sites (table 1). Clendenny, one of the two sites where the p/a ratio index ended lower than it began, is an exception in that it lost

numerous patches in 1988. Prior to 1988, this site also had an increasing p/a ratio index.

In our field sampling of these nine hill prairies, we found *Schizachyrium scoparium* and *Bouteloua curtipendula* to be by far the most frequent in occurrence (table 2), as in previous studies (Anderson 1972; Evers 1955; Kilburn and Ford 1963). Other species occurring in at least 25% of the sites are *Petalostemum purpureum*, *Panicum* spp. (panic grass), *Aster azureus* (sky-blue aster), *Andropogon gerardii*, and *Psoralea tenuiflora*. A total of 22 species were found in more than 10% of the 1 m^2 plots (table 2). The most frequent woody species were *Cornus drummondii* (rough-leaved dogwood), *Juniperus virginiana* (red cedar), and *Rhus glabra*. These woody species, however, are not necessarily indicative of hill prairie loss. These species persist in low abundance and low stature in many hill prairie sites. The woody species rank much higher in percent of total area (table 2), *Rhus glabra* ranking second, *Juniperus virginiana* fourth, and *Cornus drummondii* fifth. The only non-native species observed in more than 10% of our plots was *Melilotus alba*.

Our sampling data also show that the higher the proportion of 1940 area remaining in 1988, the larger the number of species observed in our 1 m^2 sample plots (fig. 8). Conversely, the lower the proportion of 1940 area remaining in 1988, the larger the number of sample plots that contained woody species (fig. 9).

Discussion

The results of this study suggest that hill prairies have, on average, been more than halved in size since 1940. This estimate includes only those sites that have managed to remain hill prairies during this period, and is thus a conservative estimate of the total rate of habitat loss. Much of this hill prairie loss is from woody encroachment around the borders of sites, especially by *Juniperus virginiana, Rhus glabra*, and *Cornus drummondii*. There is a natural propensity for habitat patches or units to increase in edge perimeter as the total size declines. Hill prairies are shown to be no exception to this rule, as most sites increased the amount of edge relative to a uniform shape of the size during each sample period, indicating increasing complexity of habitat patch shape. This increasing amount of edge is an important trend as woody invasion takes place mostly along edges, and therefore the rates of conversion of hill prairie to woody vegetation also increase. It is likely that what we observed at the nine sample hill prairies represents what is happening at hill prairies throughout Illinois, and thus it appears that many of the hill prairies in Illinois could disappear in the next 10 to 20 years.

The results of this study point to the single clear trend toward loss of the already rare hill prairie habitats in Illinois. The Illinois Department of Conservation and the Illinois Nature Preserves Commission are currently taking measures to protect hill prairie sites through active fire management. These measures, however, may be inadequate. Of the nine sites studied, only Revis and Fults have a history of fire management since the 1970s. While these two sites have relatively high species diversity values (fig. 8), they do not have particularly low levels of woody species invasions (fig. 9). In addition, sites acquired by the state of Illinois and managed by fire, such as Revis and Fults, have still declined in size since the 1970s. This may be a result of long intervals between fire treatments on these habitats. There is much debate on the natural fire frequency for hill prairies—estimates range from 5 to 30 years. When combating advanced woody encroachment, managed fire frequencies may need to exceed natural levels until woody invasion is suppressed. In addition, it is necessary in some cases to manually cut and remove the woody plants.

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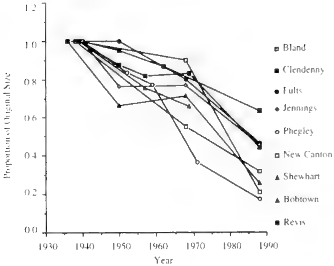

FIG. 4. The change in size of nine Illinois hill prairies between about 1940 and 1988 as measured by the proportion of the size measured in the earliest aerial photograph (see table 1).

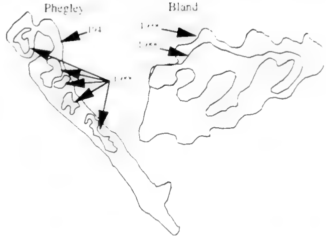

FIG. 5. Graphical depiction of the areas for Phegley (left) and Bland (right) hill prairies at the beginning and the end of the study period as digitized from aerial photographs; the inner unit(s) are from the 1988 photographs.

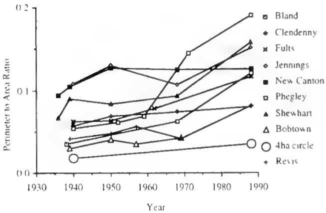

FIG. 6. The change in perimeter to area ratio for nine Illinois hill prairies between about 1940 and 1988. For reference, the change in the perimeter to area ratio for a circle that is halved in size is plotted between the 1940 and 1988 markers.

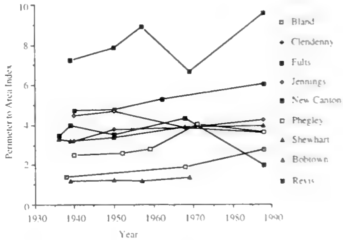

FIG. 7. The change in perimeter to area ratio index for nine Illinois hill prairies between about 1940 and 1988. This index is the perimeter to area ratio divided by the perimeter to area ratio for a circle of the same area; it is a measure of the complexity of the shape of each hill prairie.

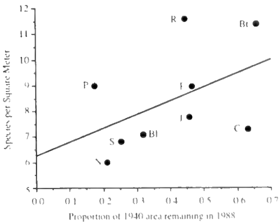

FIG. 8. Scatterplot of the average number of species sampled per square meter and the rate of recent habitat loss for nine Illinois hill prairies.

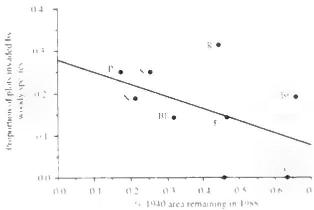

FIG. 9. Scatterplot of the proportion of 25 m^2 plots invaded by woody plant species and the rate of recent habitat loss for nine Illinois hill prairies.

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WOODY VEGETATION SURVEY OF BOIS DU SANGAMON NATURE PRESERVE, AN UPLAND FOREST IN MACON COUNTY, ILLINOIS

Douglas J. Haug[1] and John E. Ebinger[1]

ABSTRACT: A survey was made of the woody vegetation at Bois du Sangamon Nature Preserve, an upland forest in Macon County, Illinois. *Quercus alba* L. (white oak) ranked first with an importance value of 68.2 (IV 200), followed by *Acer saccharum* Marsh. (sugar maple) with an importance value of 26.6. Associated species included *Carya cordiformis* (Wang.) K. Koch, *Carya ovata* (Mill.) K. Koch, and *Ulmus americana* L. The larger diameter classes were dominated by white oak, whereas sugar maple dominated the 10-20 cm diameter class. Tree density averaged 324.4 stems/ha, and average basal area was 26.4 m^2/ha. Although only 16% of the individuals (10 cm dbh and above) were white oak, they accounted for more than 50% of the basal area.

INTRODUCTION

The upland forests of the prairie peninsula of Illinois have undergone significant changes since presettlement time (Ebinger and McClain 1991). Those not destroyed have been extensively modified by logging, grazing, and fire suppression (Rodgers and Anderson 1979). According to the historical information available, most upland forests were relatively open (Ebinger 1986a, 1987) and could be characterized as open forests or savannas, a transition between the extensive prairie found throughout much of the upland area of the prairie peninsula and the closed forests of the dissected terrain usually associated with river valleys.

The forest at Bois du Sangamon Nature Preserve is typical of the relatively mature upland forests of the Grand Prairie Natural Division (Schwegman et al 1973). Though more open and probably lacking many of our mesophytic woody species in presettlement times, the forest canopy is now closed, and like other central Illinois forests (Boggess and Geis 1966; Newman and Ebinger 1985; Ebinger 1986b), it has developed a more mesophytic woody flora, probably because of fire suppression (Rodgers and Anderson 1979; Ebinger 1986b). A detailed study of this nature preserve was undertaken to determine its woody composition and structure.

STUDY AREA

Bois du Sangamon Nature Preserve is located on the east shore of Lake Decatur, Macon County, Illinois (S4 T16N R3E). The lake forms the northwestern border of the preserve and the Norfolk & Western Railroad the southern border. The preserve is about 13 ha in size with a topographic relief of about 20 m. It is located in the midst of what was described by the Public Land Survey field notes of 1822 as land rolling and rich, dominated by oak, hickory, and elm (Hutchison 1985). Since settlement the area has undergone many changes. Major excavations occurred in the early 1900s along the eastern edge of the preserve, the Wabash Railroad was built along the southern edge, and a dam on the Sangamon River raised Lake Decatur to its present level in the early 1920s. Other past disturbances included selective logging, grazing, and the clearing of a small portion of land in the southwest corner. Hutchison (1985) reported that the owners had protected the woods from logging for fifty years prior to formal protection. The soils of the study area are Xenia silt loam on the nearly level uplands and Miami loam on the steep slopes (Dole 1990). Both are calcareous, moderately to well-drained soils with a dark grayish brown surface layer about 15 cm thick.

MATERIALS AND METHODS

During the summer of 1993, a 2.5 ha section of the upland forest was divided into 40 25 × 25 m quadrats. In each quadrat all living and dead-standing woody individuals over 10 cm dbh were identified, and their diameters recorded. From these data the density (stems/ha), basal area (m^2/ha), relative density, relative

[1] Botany Department, Eastern Illinois University, Charleston, IL 61920

dominance, importance value (IV), and average diameter (cm) were calculated for each species. The determination of the IV follows the procedure used by McIntosh (1957), and is the sum of the relative density and relative dominance of a given species.

Woody understory composition and density (stems/ha) were determined using nested circular plots 1 m^2, 10 m^2, and 100 m^2 in size, randomly located in each quadrat by blind- throwing a marker from a corner of the plot. Two additional 1 m^2 circular plots were located 5 meters to the east and west of each center. In the 1 m^2 circular plots seedlings (< 40 cm tall) and all shrubs were counted, in the 10 m^2 circular plots small saplings (> 40 cm tall and < 2.5 cm dbh) were recorded, and in the 100 m^2 circular plots large saplings (2.5–10.0 cm dbh) were tallied. Saplings were divided into 2.5 cm diameter classes. Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

Sixteen canopy and four understory tree species were encountered in the woods. *Quercus alba* (white oak) ranked highest with an IV of 68.2 out of a possible 200 (table 1). It had the highest basal area (13.8 m^2/ha), the largest average diameter (55.7 cm), and the highest relative dominance (52.3%). It occurred in all diameter classes, but 67% of the individuals were 50 cm dbh or greater. Many of these larger individuals have an open-grown appearance with low branches or branch scars within five meters of the ground and broad, open crowns, indicative of a forest that was more open in the past. *Quercus velutina* Lam. (black oak) and *Q. rubra* L. (red oak) were occasionally encountered, but were not important forest components, ranking eighth and eleventh respectively. Very few oak seedlings and saplings were found (table 2).

A few mesic, shade-tolerant species were common components of the woods. For the most part these species were common in the seedling and sapling layer, and were usually well represented in the smaller diameter classes. *Acer saccharum* (sugar maple) ranked second in importance (IV of 26.6); it had the highest relative density (17.8) and an average diameter of 18.3 cm (table 1). This species had the highest density in the understory: counts were 5833 seedlings/ha, 4825 small saplings/ha and 599 large saplings/ha (table 2). *Carya cordiformis* (bitternut hickory) ranked third (IV of 15.5) and was well represented in the seedling and sapling layers. *Ulmus americana* (American elm) and *U. rubra* Muhl. (slippery elm) were common understory species represented by many smaller diameter individuals.

Both *Carya ovata* (shagbark hickory) and *C. tomentosa* (Poir.) Nutt. (mockernut hickory) were common in the lower diameter classes. Few individuals exceeded 40 cm dbh, and average diameters for these two species were 19.3 and 23.2 cm respectively. A few seedlings and saplings were encountered, but far fewer than for the mesic species.

Tree mortality, which was relatively low in the woods, averaged 14 dead-standing stems/ha with an average basal area of 0.7 m^2/ha. American elm had the highest mortality, averaging 4.4 stems/ha, followed by slippery elm, mockernut hickory, and white oak. Mockernut hickory accounted for the highest average

TABLE 1. Densities (stems/ha), diameter classes, basal areas (m^2/ha), relative values, importance values, and average diameters of the woody species in an upland forest at Bois du Sangamon Nature Preserve, Macon County, Illinois.

Species	Stems/ha by diameter class (cm) 10–20	20–30	30–40	40–50	50–60	60–70	70+	Total stems/ ha	Basal area (m^2/ha)	Rel. den.	Rel. dom.	IV	Avg. diam (cm)
Quercus alba L.	2.0	3.2	4.4	7.6	8.8	15.6	10.0	51.6	13.8	15.9	52.3	68.2	55.7
Acer saccharum Marsh.	45.6	6.8	2.4	–	0.8	0.8	1.2	57.6	2.3	17.8	8.8	26.6	18.3
Carya cordiformis (Wang.) K .Koch	21.6	10.4	2.8	0.4	–	–	–	35.2	1.2	10.9	4.6	15.5	19.5
Carya ovata (Mill.) K. Koch	20.4	10.4	3.6	0.4	–	–	–	34.8	1.2	10.8	4.5	15.3	19.3
Ulmus americana L.	29.6	3.6	0.8	0.8	–	–	–	34.8	0.9	10.7	3.3	14.0	16.4
Carya tomentosa (Poir.) Nutt.	12.4	4.4	2.0	0.4	2.0	–	–	21.2	1.2	6.5	4.4	10.9	23.2
Ulmus rubra Muhl.	10.8	6.8	3.2	1.2	–	–	–	22.0	1.0	6.8	3.6	10.4	21.5
Quercus velutina Lam.	0.4	0.8	2.0	2.4	0.8	2.0	0.8	9.2	1.8	2.8	6.9	9.7	47.0
Ostrya virginiana (Mill.) K. Koch	23.2	–	–	–	–	–	–	23.2	0.3	7.2	1.2	8.4	12.9
Juglans nigra L.	4.0	6.0	4.0	0.8	–	–	–	14.8	0.9	4.6	3.3	7.9	25.9
Quercus rubra L.	0.8	0.8	1.2	0.8	–	0.4	1.2	5.2	1.2	1.6	4.4	6.0	46.9
Prunus serotina Ehrh.	3.2	1.6	1.6	0.8	–	–	–	7.2	0.4	2.2	1.5	3.7	23.9
Others	4.4	1.6	1.6	–	–	–	–	7.6	0.2	2.2	1.2	3.4	
Total	178.4	56.4	29.6	15.6	12.4	18.8	13.2	324.4	26.4	100.0	100.0	200.0	

TABLE 2. Density (stems/ha) of shrubs, woody seedlings, and saplings in an upland forest at Bois du Sangamon Nature Preserve, Macon County, Illinois.

Species	Seedlings (diameter <40 cm)	Saplings diameter class (cm)			
		<2.5	2.5–5.0	5.1–7.5	7.6–10.0
Trees					
Acer saccharum Marsh.	5833	4825	448	113	38
Ulmus spp.	250	175	75	35	23
Carya spp.	583	250	35	18	5
Quercus spp.	83	–	–	–	3
Sassafras albidum (Nutt.) Nees	332	–	5	3	–
Other trees	250	275	28	8	15
Shrubs					
Ribes missouriense Nutt.	417	–	–	–	–
Symphoricarpos orbiculatus Moench	250	–	–	–	–
Cornus drummondii C. A. Mey.	83	–	–	–	–
Total	8081	5525	591	177	84

dead-standing basal area (0.4 m^2/ha), followed by slippery elm. No cut stumps were found during the study. Coppice stems were also uncommon, averaging 6.8 individuals/ha. The understory tree *Ostrya virginiana* (Mill.) K.Koch (hop hornbeam) accounted for nearly 60% of the coppice individuals.

Of the understory trees on the site, only hop hornbeam was common; it was well represented in the 10–20 cm diameter class, averaging 23.2 stems/ha. *Viburnum prunifolium* L. (black haw) was also occasionally encountered, as was *Cercis canadensis* L. (redbud). Shrubs averaged 750 individuals/ha, with *Ribes missouriense* Nutt. (Missouri gooseberry) and *Symphoricarpos orbiculatus* Moench (coralberry) the most common (table 2).

Presently Bois du Sangamon Nature Preserve is an oak/maple/hickory forest. Sugar maple accounts for the highest number of stems/ha in the seedling, sapling, and 10–20 cm diameter classes. Observations indicate that the hickories and elms are increasing in importance. These data suggest that as the canopy continues to close and the forest becomes more mesic, shade-tolerant species will continue to increase in importance. In particular, sugar maple, because of its high gap-phase-replacement potential, will dominate the forest as the veteran oaks die (Runkle 1984; Pallardy et al. 1991). This eventual shift in canopy composition is a widespread phenomenon, occurring throughout much of the oak/hickory forest region (Braun 1950) of the Midwest. These changes largely reflect the elimination of disturbance regimes, particularly fires, that had maintained these forests in early successional stages (Curtis 1959). With the reduction in fire frequency, fire-sensitive, shade-tolerant species such as sugar maple, elm, and bitternut hickory are able to invade and become established.

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Additions to the Vascular Flora of Illinois

Mark A. Basinger[1]

ABSTRACT: Seven vascular plant species are reported new to Illinois: *Brachiaria platyphylla* (Grisebach) Nash, *Eupatorium hyssopifolium* L., *Ipomoea quamoclit* L., *Pennisetum americanum* (L.) Leeke, *Spiraea* × *vanhouttei* (Briot) Zabel, *Sporobolus pyramidatus* (Lam.) Hitchcock, and *Tagetes patula* L.

Introduction

Field work in southern Illinois from 1993 through 1995 has led to the discovery of seven vascular plant species new to the state. This paper describes each of these plants and provides collection information. A voucher specimen has been deposited in the Illinois Natural History Survey Herbarium (ILLS) to voucher each taxon reported here, except for *Eupatorium hyssopifolium* L., which is deposited in the herbarium at the Shawnee National Forest Headquarters in Harrisburg, Illinois. Nomenclature follows Gleason and Cronquist (1991).

Taxa New to Illinois

Brachiaria platyphylla (Grisebach) Nash (POACEAE) is an annual grass native to the southeastern United States, from North Carolina south to Florida, west to Texas, and north to Kentucky and Missouri (Correll and Johnston 1970; Hitchcock 1951; Radford et al. 1968). A member of the tribe Paniceae, this species is recognized by racemes that have a broadly winged rachis bearing glabrous spikelets up to 5 mm in length, and by its decumbent, stoloniferous habit (Hitchcock 1951).

COLLECTION DATA: locally abundant in a fallow field east of the dam at Horseshoe Lake Conservation Area, S15 T16S R2W, Alexander County, 14 October 1993, Basinger & Ketzner #7759; associated with *Bidens cernua*, *B. frondosa*, *Cyperus aristatus*, *C. erythrorhizos*, *Panicum dichotomiflorum*, *Polygonum lapathifolium*, and *P. pensylvanicum*. It was persisting at this station and in roadside ditches and fallow fields on the refuge in 1994.

Eupatorium hyssopifolium L. var. ***hyssopifolium*** (ASTERACEAE) is a perennial, native to open forests, pine savannas, sandy fields, and roadsides from Massachusetts south to Florida, west to Louisiana, and north to Ohio and Kentucky (Radford et al. 1968; Cronquist 1980; Gleason and Cronquist 1991). This species is distinguished from any other *Eupatorium* in the Illinois flora by its whorled, linear primary stem leaves, which are in 3s or 4s, are 6–40 times longer than broad, and are glandular-punctate beneath. The upper stem leaves usually have axillary fascicles of reduced leaves, and the corollas are white. Given the associated native flora and current management of the area, this population of *E. hyssopifolium* is probably native. However, a recent collection by Eric Ulaszek (2 August 1994, #2156) from Johnson County, along Interstate 24 approximately 5 miles south of Ill. 146, is probably adventive. At the Johnson County station, approximately 200 plants were found associated with *Coronilla varia*, *Festuca pratensis*, *Lespedeza cuneata*, *Rhus copallina*, and *Vernonia* sp.

COLLECTION DATA: local in sandy soil at Dean Cemetery East Barrens Ecological Area, S14 T15S R6E, Pope County, 24 October 1993, Basinger #7839; associated with *Agalinis tenuifolia*, *Lobelia puberula*, *Schizachyrium scoparium*, *Scleria pauciflora*, *Solidago juncea*, and *S. nemoralis*. It persisted at this station in 1994.

Ipomoea quamoclit L. (CONVOLVULACEAE) is an annual vine native to tropical America that readily escapes from cultivation into fields and roadsides (Radford et al. 1968; Gleason and Cronquist 1991). This species is similar to *I. coccinea* L. in the Illinois flora, but is distinguished by its pinnately divided leaves.

COLLECTION DATA: persistent in a field at the War Bluff Valley Sanctuary about 6 miles north of Golconda near the intersection of Bushwhack Road and Ill. 146, S25 T13S R6E, Pope County, 14 August 1993, Basinger #6528; associated with *Asclepias syriaca*, *Festuca elatior*, *Cirsium discolor*, and *Solidago canadensis*. It was persisting at this station in 1994.

Pennisetum americanum (L.) Leeke (POACEAE) is an annual grass native to the Old World that is planted as forage for wildlife in the southeastern United States (Clewell 1985). It is recognized by its large culms up to

[1] Department of Plant Biology, Southern Illinois University, Carbondale, IL 62901-6509

2 m tall and its large cylindrical panicles up to 50 cm long (Hitchcock 1951; Radford et al. 1968). This species has been known as either *P. glaucum* (L.) R. Brown, or *P. typhoides* (Burm.) Stapf & C. E. Hubb. in some manuals (e.g., Bor 1960), but collections at Southern Illinois University (SIU) have been determined by Michael Stieber (Morton Arboretum, Lisle, Illinois), as *P. americanum*.

COLLECTION DATA: local along the roadside of Ill. 13 north of a wetland mitigation pond approximately 75 meters west of the Saline County line, S13 T9S R4E, Williamson County, 30 September 1993, Basinger #7590; associated with *Ambrosia artemisiifolia*, *Eragrostis pectinacea*, *Oenothera biennis*, *Panicum dichotomiflorum*, and *P. virgatum*. It was not observed at this station in 1994, but new stations along Ill. 13 approximately 1 to 3 miles west of the original location were noted.

Spiraea* × *vanhouttei (Briot) Zabel (ROSACEAE) is a shrub native to Asia that has been widely planted as an ornamental around homesites in North America (Rehder 1940). Rehder (1940) reported this plant as a hybrid between *S. cantoniensis* Lour. and *S. trilobata* L. It is distinguished from other members of section Chamaedryon by its umbelliform inflorescence with leafy bracts, its arching branching habit, and its slightly 3- to 5-lobed leaves with cuneate bases that are toothed only near the apex (Rehder 1940; Gleason and Cronquist 1991).

COLLECTION DATA: persistent and spreading vegetatively at the old Weaver homesite approximately 3.7 miles south of Jonesboro along Ill. 127, SW S13 T13S R2W, Union County, 7 May 1995, Basinger #9466; associated with *Euonymus fortunei*, *Hemerocallis fulva*, *Hibiscus syriacus*, *Juglans nigra*, *Lonicera japonica*, *Prunus serotina*, and *Vinca minor*.

Sporobolus pyramidatus (Lam.) Hitchcock (POACEAE) is a perennial grass that ranges from tropical America north to Kansas and Missouri, with an adventive population in New York (Hitchcock 1950; Gleason and Cronquist 1991). It is distinguished from other species of *Sporobolus* in Illinois by its whorled lower panicle branches that are gradually reduced in length upward in pyramid fashion (Hitchcock 1951; Correll and Johnston 1970; Long and Lakela 1971).

COLLECTION DATA: locally abundant along the roadside of Ill. 3 at Horseshoe Lake Conservation Area, SE SE NE S10 T16S R2W, Alexander County, 19 August 1993, Basinger #6568; local along the roadside of Ill. 3 at the intersection with Ill. 149 about 8 miles west of Murphysboro, S8 T9S R3W, Jackson County, 6 September 1993, Basinger & Ketzner #6720; at both stations, this species was associated with *Eragrostis pectinacea*. It persisted at these stations in 1994.

Tagetes patula L. (ASTERACEAE) is an annual species, native to Mexico, that occasionally escapes from cultivation, primarily in the southern United States (Radford et al. 1968; Gleason and Cronquist 1991). The genus *Tagetes* can be distinguished from other members of the tribe Heliantheae by the presence of a cylindrical involucre of phyllaries that are united to the apex (Cronquist 1980). This species is distinguished from *T. erecta* L. by its deep red orange heads surrounded by involucral bracts no more than 1.5 cm long (Bailey 1949; Radford et al. 1968).

COLLECTION DATA: persistent along a crop field-successional forest margin at Horseshoe Lake Conservation Area, NE SW S17 T16S R2W, Alexander County, 5 July 1993, Basinger #6031; associated with *Ambrosia trifida*, *Artemisia annua*, *Festuca elatior*, *Polygonum pensylvanicum*, and *Prunus persica*. It was persisting at this station in 1994.

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NEW POPULATIONS OF RARE SPECIES IN SOUTHERN ILLINOIS

Robert Todd Bittner

Populations of *Calamagrostis porteri* Gray ssp. *insperata* (Swallen) C. Greene (reed bent grass) and *Carex willdenowii* Schkuhr (Willdenow's sedge) were recently discovered in Pope County in southern Illinois at Bell Smith Springs Ecological Area and at Lusk Creek Canyon Wilderness Area. Both Bell Smith Springs and Lusk Creek are floristically diverse areas that support a wide variety of community types and contain several other threatened and endangered species (U.S.D.A. 1992).

Calamagrostis porteri ssp. *insperata* was originally described from Jackson County, Ohio, in 1934 (Van Schaack 1954). In the 1930s, another Ohio population was discovered from Vinton County (Braun 1967), and three populations were discovered in Ozark ((Steyermark 20043 MO), Douglas (Steyermark 23350 MO), and Texas (Steyermark 16620 MO) counties, Missouri, by Julian Steyermark (1963) although the last collection was mistakenly not included in *The Flora of Missouri*. Recently, the historic Missouri populations were relocated, along with over 60 additional populations from six Missouri counties (Summers 1993; Ellshoff 1993). The two historical populations in Ohio have also been relocated, along with new populations within the Vinton County site (Spooner 1981). An additional six populations have been reported from two sites in Kentucky (Cambell et al. 1992).

Calamagrostis porteri ssp. *insperata*, an Illinois threatened species (Herkert 1994) and a federal candidate for listing as an endangered or threatened species (Federal Register 1993), was first discovered in Illinois in 1991 at Bell Smith Springs by Bill Summers of St. Louis, Missouri. In 1992, a second Pope County population was discovered in the Lusk Creek Canyon Wilderness Area by John Schwegman. During 1993, three additional populations were located, two at Bell Smith Springs and one at Lusk Creek Canyon. This grass grows rhizomatously, forming clonal populations on cool, mesic, north-facing bluff edges and under tree falls in high-quality oak-hickory forests. The populations of *C. porteri* ssp. *insperata* vary from 500 to over 18,000 tillers, but flowering individuals are extremely rare; only one was observed in 1993 (Bittner 1995).

Three new Illinois populations of *Carex willdenowii*, a state endangered species (Herkert 1991), were discovered in 1993, two at Bell Smith Springs and one at Lusk Creek Canyon. At all three sites *C. willdenowii* was found growing in association with *Calamagrostis porteri* ssp. *insperata*. Other *C. willdenowii* populations in Illinois are located in Gallatin and Union counties and other portions of Pope County. *Carex wildenowii* is superficially similar to many common sedges and may often be overlooked; it may be more common than present records suggest.

Specimens of both species have been deposited in the Illinois Natural History Survey Herbarium, Urbana, Illinois.

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